A PROPOSAL FOR
A
MANITOBA INSTITUTE OF TECHNOLOGICAL INNOVATION
June 1985

Manitoba Research Council
Ad Hoc Committee
on
Technological Innovation Education

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July 1, 1985

Professor Marion Vaisey-Genser
Chairperson
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The Ad Hoc Committee on Technological Innovation Education is pleased to submit its report on a proposed interdisciplinary initiative to provide training and related functions in technological innovation.

These recommendations are the fruition of seven intense workshop sessions held between April and June 1985, in which the Committee members enthusiastically committed their expertise to evolve this plan for a Manitoba Institute of Technological Innovation - MITI.

The Committee vigorously supports the creation of MITI and urges expedient government action to this end, so that the Institute may contribute to employment and economic development in Manitoba through technological innovation.

Respectfully submitted,

M. Chaturvedi, P. Eng.
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Technological Innovation Education

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1. INTRODUCTION:

In April 1985 various individuals and organizations were requested to participate in an Ad Hoc Committee of the Manitoba Research Council to consider the proposed development of a Manitoba initiative in technological innovation education. The formation of this committee was in response to a long-standing desire by the Manitoba Research Council to address this educational requirement.

The Ad Hoc Committee on technological Innovation Education (TIE), composed of a broad cross-section of expertise from academia, government and the private sector, met seven times between April and June 1985. The Committee's Terms of Reference included the consideration of "the merits of a university-based, interdisciplinary initiative to provide training and related functions in the area of technological innovation". Specific points considered were:

- rationale
- alternative concepts
- functions/components
- funding considerations
- linkages

By reviewing relevant background information and drawing upon their experiences, the Committee members recognized that technological innovation and commercialization, and the resultant creation of new businesses and jobs, is playing an increasingly important role in the economies of the United States and Canada.

Technological innovation is the transformation of scientific and technological ideas into a new or significantly improved saleable product or an operational process. It includes whatever scientific, technical, commercial or financial steps necessary for this transformation.

All levels of government - city, provincial/state and federal - are increasingly providing support and incentives for the creation of new innovative businesses and the upgrading of capabilities of established industry. The end-result of this emphasis on technological innovation and commercialization is the phenomenon of the rapid growth of many technology-based, capital and skilled-labour intensive, small firms in jurisdictions such as California's "Silicon Valley" and, to a lesser extent, the Ottawa Valley, near Kanata, Ontario.

In response to the rising economic importance of small business and the perceived need for larger firms to be more innovative, there has been a recent surge in the number of research centres and university-based programs with a focus in this area. The efforts of the Massachusetts Institute of Technology, the University of Waterloo and the associated Canadian Industrial Innovation Centre, and the York Enterprise Development Centre are notable in this respect.

The main objectives of these technology innovation programs are:

- to address current and emerging problems and opportunities of national significance in science and technology;
- to relate such problems and opportunities to the exploitation of technology to achieve economic goals of employment, exports and growth;
- to specifically channel scientific and technological skills into innovative ventures to develop commercial products or processes; and
- to provide the training and development (i.e. the managerial expertise) for those innovative individuals who can translate technical concepts into business opportunities.

The Committee recognized that a clear need exists for job creation and economic development in Manitoba derived from technological innovation. A significant source of technical innovators is resident in Manitoba's universities and community colleges. It is, therefore, proposed that a Manitoba educational initiative in technological innovation be established for students, graduates, and other individuals with an engineering, science or technical background, within the framework of a Manitoba Institute of Technological Innovation - MITI.

2. RECOMMENDATIONS:

In recognition of the increasing importance of technological innovation and commercialization to economic development and the creation of new ventures, the Ad Hoc Committee on Technological Innovation Education recommends:

(a) a Manitoba Institute of Technological Innovation be established for the education, coordination and promotion of technological innovation;

(b) the initiative take the form of an interdisciplinary institute, with its own Advisory Board, administered through the Manitoba Research Council;

(c) the Institute be headed by a Director, with appropriate support staff shared with the MRC Directorate;

(d) the Institute will fund educational initiatives in technological innovation for graduates, students, and other individuals with an engineering, science or technical background;

(e) the major educational initiative take the form of a Chair of Technological Innovation in the Faculty of Engineering, University of Manitoba and filled by a recognized professional;

(f) the Faculty of Engineering will offer a one-year certificate program, which will include coursework and a practicum;

(g) course segments would be available to those not enrolled in the program, and be integrated with other academic programs;

(h) MITI establish firm links with all other related organizations and programs in Manitoba, and provide a promotion and coordination function for technological innovation in the Province;

(i) the physical location of MITI be with the MRC Directorate, possibly at the proposed Science Place Canada;

(j) funding be provided to the amount of $285,000 for the establishment of MITI and its first year of operation, and $345,000 for annual recurring costs for an additional four years; and

(k) the Province act expediently on the above recommendations.

3. RATIONALE:

On behalf of the Committee, a review of the issues associated with technological innovation and related educational initiatives was undertaken (Attachment A). This review concluded that science, technology and innovation are rapidly increasing in economic importance to our society and that educational programs, when adapted to local conditions, can promote technological innovation.

Efforts are currently underway to strengthen technological innovation in Manitoba. MRC's Industrial Technology Centre (ITC) and Canadian Food Products Development Centre (CFPDC), after being established through the federal/provincial Enterprise Manitoba agreement, are enjoying continued success in transferring advanced technology to Manitoba industry. The University of Manitoba is currently establishing an Institute of Regional Technological Development through the Faculty of Engineering and a Chair of Entrepreneurship through the Faculty of Administrative Studies. The Province has developed a technology strategy that emphasizes technology adaptation by all industry and the stimulation of creative niches (as exemplified by the Technology Commercialization and Strategic Research Support programs). An initiative in technological innovation education would be complementary to all of these efforts.

The proposed initiative would facilitate the creation of new business and new jobs in Manitoba by removing barriers to innovation (e.g. negative attitudes; and lack of training/education and evaluation/appraisal for new ideas) and increase the overall numbers and success rate of new ventures. Such an initiative would assist in retaining technical professionals in the Province, and strengthen the overall technological infrastructure.

The initiative would also be timely, given the current international emphasis on advanced technologies as a key to economic growth, and that technology is the basis for 30 to 50% of all business start-ups. Action in this area would be highly appropriate for the Province, given the importance of small business to Manitoba's economy, and as a mechanism to offset an overdependance on branch plants and the resource sector.

Eventually, Manitoba could develop into a "centre of excellence" in technological innovation for Western Canada.

4. CRITERIA:

It is important that the proposed initiative be practical and focussed, and directly related to new job creation, business development and increased economic wealth. The initiative should avoid the duplication of existing services and programs by meeting an unsatisfied need, while simultaneously remaining as flexible as possible to changing circumstances.

Related services and programs in Manitoba are summarized in Attached B, together with several programs that are proposed for the near future. It is apparent that a wide variety of support already exists - broad entrepreneurial education; private consultants; government and university technology commercialization assistance; government technical, business and financial assistance, etc.

Many technical innovators and inventors in Manitoba appear unaware of the wide variety of support options available. An important role of the proposed program could be a "clearing-house" to coordinate these diverse elements. Cooperation would be enhanced if representatives from these related organizations sat on the proposed program's "advisory board".

5. ALTERNATIVE CONCEPTS:

The Committee gave careful consideration to alternative organizational models for the proposed initiative. The variables included focus/foci; the relationship to the overall technological and business management environments; potential target groups; possible functions and services; operating modes; and key operational elements.

Specific organizational models considered included:

- university-based
- college-based
- independent organization
  (non-profit education institute or joint venture);
- private sector venture;
- government agency (e.g. MRC/ITC);
- government department; and
- joint venture.

6. FOCUS:

The Committee concluded the initiative should fill an important niche that currently is not being addressed: namely, the provision of practical training in applied technological innovation, leading to the commercial exploitation and application of technology-based products and processes. The target population would be students, graduates and other individuals with an engineering, science or technical background. The majority of this population would be comprised of engineering and science undergraduates and graduates and community college students. The academic program would address, in a general sense, the issues and needs associated with the current dynamic technological environment.

Eligibility requirements would remain flexible. For example, students from medicine and agriculture would be eligible, as would those with promising technical ideas from other disciplines. The certificate course would be open to graduates of all Manitoba universities and colleges and extension courses could eventually be provided for the general public. Consideration should be given to enrolment on both a full-time and part-time basis.

Special outreach efforts could be undertaken for members of special interest groups (e.g. natives, handicapped, women, etc.) to encourage those with promising technical capabilities to enrol.

Those eligible for the academic program would not necessarily have to be "inventors", but could also include those capable of innovatively employing the ideas of others.

In addition, the initiative would provide an overall "focal point" for technological innovation activities in Manitoba, providing a distinctive image to the community-at-large. Public awareness of the importance of technological innovation and the major issues associated with it, would be increased.

7. MODEL

After careful consideration of the initiative's requirements and alternative organizational models, the Committee proposes that the program be administered as an interdisciplinary institute associated with the Manitoba Research Council, and that this institute in turn support a Chair of Technological Innovation associated with the Faculty of Engineering, University of Manitoba. This structure would provide ready access to technical resources and the majority of Manitoba's target population. It was determined that the Institute should be associated with MRC, because its innovative, dynamic nature would best fit with the provincial research council's mandate on science and technology.

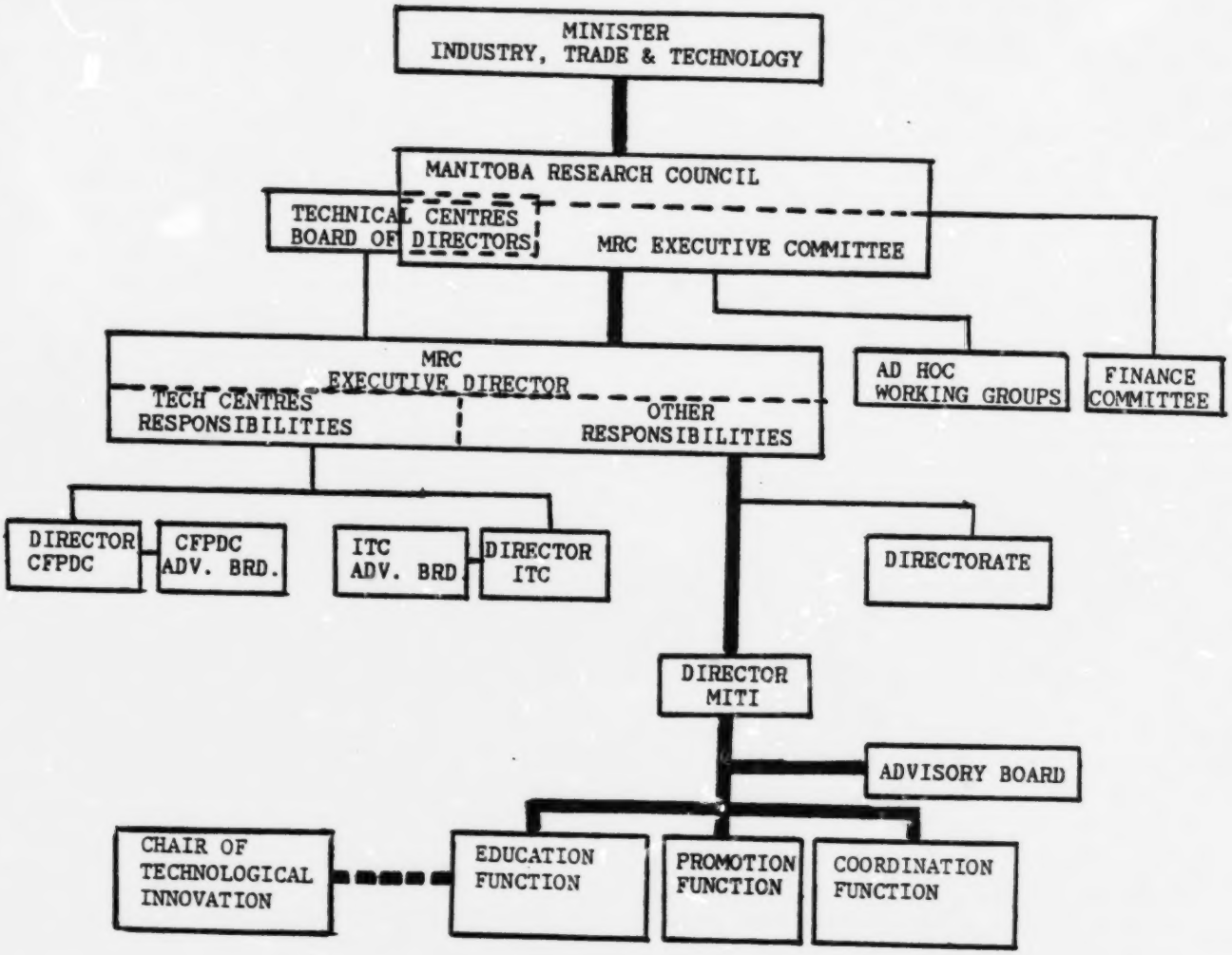
The Institute would have an Advisory Board comprised of individuals with a commitment to technological innovation in Manitoba, and would be headed by a Director.

The location of the Institute could be with the MRC Directorate, perhaps at the proposed Science Place Canada. The Chair would reside at the University of Manitoba. Ultimately, the success of the Institute will be dependent upon the calibre of the individuals chosen to lead the program: the Director and the Chair. Many of the actual operational details of the program should be left to the expert judgment of these individuals.

Figure One is a potential organizational model for the Manitoba Institute of Technological Innovation (MITI) and the associated Chair of Technological Innovation.

PROPOSED ORGANIZATIONAL STRUCTURE
OF THE MANITOBA INSTITUTE
FOR TECHNOLOGICAL INNOVATION (MITI)

FIGURE I



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8. ACTIVITIES:

Upon the establishment of the Institute with its Director, the first priority would be to fund the Chair, which would in turn establish the major education and training component of the Institute. The establishment of the Chair and the Program would be dependent upon the approval of the University of Manitoba.

Two levels of training activities are proposed: a one year intensive, full time certificate program which could also be accessed on a part-time basis; and, at the post-secondary level, students enrolled in other programs would obtain course credits by completing individual certificate courses.

The certificate program would require the successful completion of a series of courses (see Attachment C for a summary of potential course offerings) and a practicum with the objective of the commercialization of a new technological product or process in Manitoba. The program could consist of case studies, courses, seminars, workshops, projects and related field work, conferences, practicum research, and involvement with a business start-up.

It would be necessary to offer only certain core courses directly through the program, while others would be offered through existing university and college sources (e.g. Faculty of Administrative Studies and the proposed Chair of Entrepreneurship at the University of Manitoba, and courses offered by Red River Community College), and non-university organizations (e.g. Business Development and Tourism, the Federal Business Development Bank, private consultants).

Other activities of MITI would include:

- the coordination of technology innovation in the Province, by acting as a focal point and image to the community-at-large and sponsoring such activities as conferences, seminars and workshops;

- promotion through such activities as the provision of grants and awards for excellence; and

- acting as a source of information and referral.

The Institute would emphasize co-ordinating its efforts and creating linkages and interfaces with other relevant organizations (e.g. IT&T's Technology Commercialization Program, MRC's ITC and CFPDC, TIEM Canada, Science Place Canada, and all of Manitoba's universities and colleges. For example, MRC's Executive Director and the Directors of ITC and CFPDC could sit on the Advisory Board, while the physical location of MITI at Science Place Canada could provide a focal point for the Province's participation.

As time and other available resources permit, MITI and the Chair could gradually develop other activities, such as research on the technological innovation process and the technological environment; brokerage; consulting; and advisory, evaluation and validation services. Over time, perhaps five years, the University of Manitoba would assume financial responsibility for the Chair.

9. OUTPUT:

It is recommended that the overall success of MITI should be evaluated by measurements of such tangible outputs as:

- business start-ups;
- technological innovations;
- skills transferred to new and existing industry;
- private sector support;
- certificates awarded;
- courses completed; and
- number of new jobs created.

One of the Institute's initial tasks would be to develop an evaluative mechanism to measure its overall effectiveness. In terms of job creation, existing technological innovative education initiatives, such as York University's Enterprise Development Centre, estimate that up to 40% of their students will be self-employed within five years after graduation. Therefore, if the Technological Innovation Program produces some 20 graduates per year, some 8 firms per year will be created over time. Other graduates might be employed in an intrapreneurial capacity in existing companies.

While not directly related to new enterprise and job creation, the coordination and advocacy components of the Institute will strengthen existing industry and therefore increase economic and employment development through the improvement of the overall business climate in the Province.

10. FUNDING:

Primary and complementary sources of funding for the establishment of MITI could possibly be secured from various funding sources from the provincial and federal government, universities and colleges, and the private sector (see Attachment D).

A preliminary estimate for the first year start up budget is $285,000, as detailed on page 10 and based upon the following assumptions:

- a senior level professional will head the Institute;
- a world-class academic will fill the Chair;
- support staff will be in place;

- the office and staff support for the Chair will be provided by the University of Manitoba;
- the Institute will locate and pay for its own premises;
- the Institute will equip its offices.

The budget for the four following years of operation, based on increased operational commitments, is $345,000 per annum, on page 10 and based on the following assumptions:

- the Institute will be fully operational with no further capital requirements;
- the Chair will engage in significant education, training and related activities;
- the Institute will engage in significant coordination and promotional activities;
- salary increases are not included; and
- all figures are in constant 1985 dollars.

The University of Manitoba should become financially responsible for the Chair at the end of the five year period.

MANITOBA INSTITUTE FOR TECHNOLOGICAL INNOVATION

Preliminary Budget
($000 1985)

	YEAR	
	1	2-5
Capital Costs		
Office Furniture and Equipment	15.0	-
Operating Costs		
Director		
. Salary	50.0	50.0
. Benefits	17.0	17.0
. Support (1/2 Person Year)	20.0	20.0
Chair . Salary	60.0	60.0
. Benefits	15.0	15.0
. Operating Expenses	10.0	10.0
. Research	20.0	70.0
Promotion and Coordination	30.0	55.0
Office Supplies	5.0	5.0
Library	13.0	13.0
Rent	10.0	10.0
Miscellaneous (Travel, Meetings, etc.)	20.0	20.0
Sub-Total Operating Costs	270.0	345.0
TOTAL	285.0	345.0

ATTACHMENT "A"

TECHNOLOGICAL ENTREPRENEURSHIP:

A REVIEW

Introduction

Today the notions of "entrepreneurship" and "technological innovation" are in vogue. Small businesses are playing an increasingly important role in the economies of the United States and Canada. Technological change and innovation is generally recognized as an important element of this new-wave of entrepreneurship.

Recognition of the rising economic importance of entrepreneurship has recently stimulated a variety of organizational support in the U.S.:

> "In amounts unheard of since the late 1960's, venture capitalists are pouring money into new and existing small businesses. City, state, and federal agencies, which have traditionally been partial to the financing and labor needs of large corporations but realize that small businesses have a great potential for providing new employment, have devised financing and other assistance programs to encourage entrepreneurs. Several hundred colleges and universities - versus only a handful a decade ago - offer courses on starting and operating small businesses. And dozens of small-business organizations, many of them offshoots of established chambers of commerce, have sprung up in cities around the country."[1]

The purpose of this brief review is to assess the meaning and importance of technological entrepreneurship and university-based mechanisms for fostering and increasing the managerial expertise of technological entrepreneurs.

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1 David E. Gumpert, "Entrepreneurship: A New Literature Begins", Harvard Business Review, (March-April 1982),p.50.

Key Concepts

Technology has been defined by James R. Bright (1978) as consisting of three main elements:[2]

(1) "the physical things - tools, machines, and materials that mankind uses for all activities";

(2) "the software aspects of technology including technical processes and procedures such as heat-treating sequences, computer programs, operations research techniques, and the FAA's traffic control system for civil aviation"; and

(3) "definitional systems that determine and describe the foregoing such as the SAE standards for motor oil, NEMA standards for electric motor insulation, and standards for screwthreads".

A possible fourth element could include such non-technical "social technologies" as welfare and monetary systems.

In general, "technology denotes the broad area of purposeful application of the contents of the physical, life and behavioural sciences", and "comprises the entire notion of technics as well as the medical, agricultural, management and other fields with their total hardware and software contents."[3]

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2 James R. Bright, Practical Technology Forecasting, (Austin: The Industrial Management Centre, Inc., 1978), p.6.

3 Erich Jantsch, Technological Forecasting in Perspective, (Paris: OECD, 1967), p.15.

"Innovation" has been referred to as a renewal - "the improvement of the old and the development of new capabilities of people and their organizations".[4] In this context innovation is not the anarchistic destruction of the old, but is, rather,the adaptive change and improvement of existing systems. Industrial innovation can be defined as the transformation of an idea into a new or significantly improved saleable product or an operational process in industry and commerce.[5] It includes whatever scientific, technical, commercial or financial steps necessary for the successful development and marketing of new or improved products, processes and equipment. Technological innovation is the growth in the power of technology to provide new and improved products and services and is essential to the birth and growth of industries and to the social, economic and political health of nations.

"Entrepreneurship" is typically taken to mean the creation of new enterprises, the melding of an individual with a business opportunity.[6] An element of personal risk-taking and "will-to-succeed" is inherent in entrepreneurship. Small-business undertakings are typically associated with entrepreneurship. Small business in Canada is generally defined as those businesses with up to $2 million in annual sales and/or employing up to 50 people, with the majority employing fewer than 20 people.[7] In the U.S., firms with up to 500 employees are often classified as small businesses. The Association of Canadian Venture Capital Companies (ACVCC) has categorized small businesses into three distinct types, based upon entrepreneurial orientation:[8]

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4 J. A. Morton, Organizing for Innovation, (New York: McGraw-Hill Book Co., 1971), p.1.

5 H. Stead, The Measurement of Industrial Innovation, (Ottawa: Science, Technology and Capital Stock Division, Statistics Canada, 1985), pp.3-4.

6 James Donald Powell and Charles F. Bimmerle, "A Model of Entrepreneurship: Moving Toward Precision and Complexity", Journal of Small Business Management, (January 1980), p.33

7 Department of Regional Industrial Expansion, Consultation Paper on Small Business, (February 1985), p.3

8 ACVCC, A Response To: The Consultation Paper on Small Business, (March 21, 1985), pp. 1-2.

(1) The "life-style" business in which one or two individuals offer a service to fulfill a need for independence (e.g. the "mom and pop" grocery store);

(2) of greater economic significance, the "foundation" type business which has a hundred or more employees and equipment, supplies goods and services, with a moderate, if unspectacular, growth rate; and

(3) from an entrepreneurial perspective most importantly, the "high potential" business, with a high rate of growth (limited only by managerial capability and external equity), spectacular employment possibilities, and an often (but not always) technological basis.

A 1983 Study by the Human Development Centre of Winnipeg of 100 Manitoban entrepreneurs found that the following are the most important small business, entrepreneurial success factors:[9]

- Positive Attitude
- Commitment
- Personal Energy
- Realistic Expectations
- Encouragement from Living Partner
- Training/Education
- Market Demand
- Patience
- Low Overhead
- Contacts

Many of these factors coincide with those discussed by J. Mancuso (1973)[10] and others. It is important to note here that training and education are factors that can be used to enhance the individual characteristics of latent entrepreneurs.

In summary of this section, "technological entrepreneurship" is the process of the creation of new, small businesses that are innovative and whose products or production processes are science or technology-based. Technological entrepreneurship can be differentiated from entrepreneurship in that special managerial and technical skills are required to effectively compete in today's rapidly evolving international commercial technology marketplaces. It is important to note that the technological entrepreneur does not necessarily have to be the creator of the innovation that is commercialized.

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9 Human Development Centre of Winnipeg, Minding Her Own Business: A Study on Self-Employment in Manitoba, (1983), p.12

10 Joseph Mancuso. Fun and Guts: The Entrepreneur's Philosophy, (Reading: Addision-Wesley Pub. Co., 1973, 208 pp.).

Technological Entrepreneurship and Economic Growth

New, Small businesses are becoming increasingly important for national economic growth. In the U.S., the post-World War Two trend of big business and government growth has been reversed in favour of small business creation. As noted management scientist, Peter F. Drucker (1984) has stated:

> "It is no longer news that small and new businesses provided most of the 20-odd million new jobs generated from 1970 to 1980 by the American economy. What is not generally known, however, is that this trend has continued, has even accelerated, during the recent recession. Indeed, over the last three years, Fortune "500" companies have lost some three million jobs, but businesses less than ten years old have added at least 750,000 jobs and slightly more than a million new employees."[11]

While Drucker maintains that in entrepreneurship "the United States is way out in front", small business is also playing an important role in Canada. The following salient points can be made about Canadian small business today:[12]

- There are 750,000 small businesses.
- Within the small business sector there is a large number of start-ups and close-downs each year, but the total net number of new businesses is increasing only marginally (there is room for increased and improved entrepreneurship).
- The majority of small businesses employ fewer than 20 people. Small businesses provide 26% of total Canadian employment.
- Small businesses accounted for virtually 100% of the net job creation over the period of 1978-1982. (It should be noted that this positive performance by small firms was partially influenced by the effect of the economic downturn in 1982 on larger firms).

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11 Peter F. Drucker, "Our Entrepreneurial Economy", Harvard Business Review, (January-February 1984), p.59. Emphasis in original.

12 DRIE, Consultation Paper on Small Business, pp. 3-4 and p.16.

- In 1980, approximately 96% of firms operating in Canada reported annual sales below $2 million; most are in the category of under $250,000.

- They contribute approximately 30% of the private sector gross domestic product.

- The majority are in retail trade, business and personal services, and construction.

- The average age of Canadian entrepreneurs is between 35 and 4t, and is getting lower.

- Young people and women are playing a larger role in small business ownership: during the period of 1964-1980 the number of new small business proprietors increased by 50%, while the proportion of businesses owned by women almost tripled and those owned by persons under 30 more than doubled.

- Manitoba has (as of 1980) just under 5% of the total number of Canadian small businesses and total small business annual sales (which is appropriate for its total percentage of Canadian population, some 4.2% as of 1984).

However, it has recently been clearly indicated that if Canada is to become internationally competitive in the manufacturing and service industrial area, it must formulate policies that highlight the entrepreneur as the prime agent of economic growth.[13]

While Drucker (1984) argues that, in the U.S., less than one-third of the new-wave of entrepreneurship can be directly attributable to "high-tech", he does acknowledge the overriding effect (either directly or indirectly) rapid technological change is having on new small businesses:

> "The rapid evolution of knowledge and technology made it possible, even 15 years ago, to see that the last decades of the twentieth century would more closely resemble the last decades of the nineteenth (when a new major technology leading almost at once to the emergence of a new industry appeared on average every 18 months) than they would the 50 years following World War 1. And we can say with high confidence that we are no more than midway into this period of renewed technology-based entrepreneurship .[14]

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13 Donald C. Webster, 1985: Methods to Stimulate Entrepreneurship and Jobs in Canada, (Presentation to the National Economic Conference, Ottawa, March 22, 1985, 12.pp.).

14 Drucker, op.cit., pp.60-61. Emphasis added.

In fact, Drucker proposes that the U.S.is in the "first stages of a long-term Kondratieff (wave) expansion", in which national economic development is predicted upon industrial technological innovation and new market opportunities, that is a result of "entrepreneurial energy" rather than centralized government planning. However, Drucker cautions that "the emergence of the entrepreneurial economy is as much a cultural and psychological, as it is an economic or technological, event" and that the use of "systematic management practises also distinguish today's successful high-tech entrepreneurs".

In addition, it should also be emphasized that many general principles of entrepreneurship are finding increasing utility within larger corporations (so-called "intrapreneurship" in which certain functional groups within an organization are increased autonomy and opportunities for personal and group profits based upon performance), as are the principles of the scientific management of technology in innovation, research and development, engineering and production.

In summarizing the relationship between technological entrepreneurship and economic growth, Edward E. Williams (1983) has hypothesized that entrepreneurship is a creative process, that entrepreneurial activity stimulates innovation, and that economic growth depends upon the existence of an innovative environment. He concludes:

> "...few could argue with the proposition that entrepreneurship is an essential determinant of economic development. Moreover, it is very likely to be the case that entrepreneurship is far more important than other variables (such as the rate of saving, the capital stock of society at a point in time, etc.). This conclusion has some incredibly important implications because, unlike other economic factors, the supply of entrepreneurship can be limitless.
>
> ...entrepreneurial activity involves creation and innovation, and the creative process may be fostered. It is altogether possible that creativity can even be taught...
> If this is, in fact, the case, there can be no logical limits to economic growth"[15]

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15 Edward E. Williams, Entrepreneurship, Innovation and Economic Growth", Technovation, (1,1983), pp.13-14. Emphasis added.

The end-result of the combination of entrepreneurial spirit and technological innovation is the phenomena of the rapid growth of many technology-based, capital and skilled-labour intensive small firms in jurisdictions such as California's "Silicon Valley" and, to a lesser extent, the Ottawa Valley, near Kanata, Ontario.

Entrepreneurship Programs

In recognition of the rising economic importance of small business entrepreneurship and the perceived need of larger firms to inject an element of innovative "intrapreneurship" within their organizational structures, there has been a surge in the number of research centres or university-based programs that focus on entrepreneurship. While in 1967 only 6 U.S. programs were dedicated to entrepreneurship, today there are some 150.[16] Most business schools today offer courses on entrepreneurial management. Many such programs, such as those of MIT and the University of Waterloo, are placing an increasing emphasis on technology-based entrepreneurship, the management of technology in large organizations, and industry-university cooperation.

M. Bartell (1983) has summarized the rationale for such programs[17]

- to address current and emerging problems and opportunities of national significance in science and technology;
- to relate such problems and opportunities to the exploitation of technology to achieve economic goals of employment, exports and growth;
- to specifically channel scientific and technological skills into entrepreneurial and innovative ventures to develop commercial products or processes; and
- to provide the training and development (i.e. the managerial expertise) for those entrepreneurial individuals who can translate technical concepts into business opportunities.

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16 Anon., "B-Schools Try to Church Out Entrepreneurs", Business Week, (March 5, 1984), p.102.

17 Marvin Bartell, A Proposal for a Graduate Program in Technology, Science and Entrepreneurship (unpublished paper, University of Manitoba, January 1983), p.1.

A program in technological entrepreneurship would typically pursue the activities of course development and presentation, the promotion of technology management (through such activities as conferences, seminars, consulting, etc.) and research and publication activities. Examples of courses could include:[18]

- Introduction to Technology Management
- Understanding Specific Technologies
- Marketing and Technology
- Financing Technology
- Production Technology
- Technology, Accounting, and Control
- Environments for Technological Growth
- Effects of Technology on Human Relations
- Managing Innovation
- Managing Creativity

A broader-based management of technology program (such as MIT's) would place an emphasis on large and small company technology management issues. Innovation centres, which provide new enterprise management and technical advice and often low-cost incubation space, are also often association with technological entrepreneurship programs (e.g. MIT, Waterloo and York).

Table One presents a summary of representative U.S. and Canadian entrepreneurial studies programs. The remainder of this section shall provide case studies of the programs offered by MIT, the University of Waterloo/ Waterloo Industrial Innovation Centre, and York University.

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18 Marvin Bartell, A Proposal for a Graduate Program in Technology, Science and Entrepreneurship (Unpublished paper, University of Manitoba, January 1983), p.4.

TABLE ONE: Representative Entrepreneurial Studies Programs

Program	Description
. Management of Technology Program, MIT (Sloan School of Management and School of Engineering)	- Management techniques/issues for industrial technology organizations. - large business orientation.
. Management of Research Development and Technology-Based Innovation, MIT	- two week summer program offered by Management of Technology Program. - continuing education.
. The Industry/Innovation Centre Cooperative Program, MIT (School of Engineering)	- innovation centre. - continuing education on entrepreneurship. - small business and technical orientation. - courses through School of Engineering on entrepreneurship.
. Canadian Industrial Innovation Centre, Waterloo	- innovation centre. - continuing education. - small business and technical orientation. - close cooperation with University of Waterloo.
. University of Waterloo, Faculty of Engineering	- specialized course on entrepreneurship for chemical engineers. - other course for other types of engineers. evening courses offered to general public. close cooperation with CIIC and Waterloo Centre for Product Development.
. Entrepreneurial Studies Program and Enterprise Development Centre, York University	- innovation centre. - largest entrepreneurial studies program in North America. - large and small business orientation. - linkage with science faculty.
. Centre for Entrepreneurial Development, Carnagie Mellon University	- entrepreneurial and intrapreneurial management.
. Harvard Business School	- entrepreneurial and intrapreneurial management.
. School of Organization and Management, Yale University	- entrepreneurial and intrapreneurial management.
. J. L. Kellogg Graduate School of Management, Northwestern University	- entrepreneurial and intrapreneurial management.
. Research Centre for High Technology, Carlton University, School of Business	- "educational services to high-tech firms to upgrade and expand management skills".

MIT:

The Massachusetts Institute of Technology has two programs associated with technological entrepreneurship:

(1) The Management of Technology Program and an associated summer course, the Management of Research, Development, and Technology-Based Innovation; and

(2) The Industry/Innovation Centre Cooperative Program.

Initiated in 1981, the Management of Technology Program is not strictly devoted to technological entrepreneurship per se, but is a broader-based graduate program that focuses on the management of engineering, R&D and innovation in both large and small firms (Appendix A). However, several graduates of this 12 month program have recently established technology-related start-up firms. The program is primarily intended to enhance the managerial skills of established scientists and engineers whose career paths require responsibility in managing technical activities and organizations. The related Management of Research, Development and Technology-Based Innovation course is conducted during the summer for two weeks and is primarily focussed on the larger business and government organization (Appendix B). The course attempts to provide an understanding of the underlying technological innovation process and improvement of related management skills. Behavioural science and organizational systems analysis management skills. Behavioural science and organizational systems analysis management techniques are stressed, in addition to related strategic planning and marketing areas. Enrolment is strictly limited. The Management of Technology Program is a joint Sloan School of Management and School of Engineering Program.

The Industry/Innovation Centre Cooperative Program is one of ten similar centres situated throughout the U.S. that have been funded through the National Science Foundation. While organized in the School of Engineering, the Centre is not strictly an academic program, but provides practical business and technical advice to both existing and start-up firms (Appendix C). In effect, faculty members and students solve industrial problems, with the output of the program being newly-developed products and product-concepts which can be integrated into the product lines of the participating firms. The Centre also provides educational and technical assistance to technically-oriented entrepreneurial students through course offerings within the School of Engineering and technical advice. Continuing education courses, workshops and seminars are regularly offered to the general public, with small closed advisory sessions for start-up firms. While exact figures are not available it is estimated that the Centre has played a significant role in the start-up of 35 firms per year for the past six years (two-thirds of these through public open sessions and one-third in closed workshops), and provides training to some 100 students per year.

Waterloo:

Both the University of Waterloo and the Canadian Industrial Innovation Centre at Waterloo provide education and services for technological entrepreneurship (Appendix D). The University of Waterloo's Faculty of Engineering currently teaches two undergraduate courses on technological entrepreneurship. One specifically addresses the needs of chemical engineers ("Chemical Engineers as Entrepreneurs"), while the other is aimed at the remainder of the engineering departments. Both of these popular courses are intended to provide an "awareness" of entrepreneurship to engineering students, and a total of some 250 students per year have attended the courses for the past several years. Night courses are available for the general public, and it is estimated that 5 to 12% attending these courses are small business entrepreneurs, while various other intrapreneurs within larger firms. Extensive use is made of entrepreneur guest lecturers with the benefit of practical experience. A close working relationship has been established with the Centres for Industrial Innovation and Process Development at Waterloo. (The Waterloo Centre for Process Development is an organization that affects the transfer of research and development results from the University of Waterloo to private industry).

The Industrial Innovation Centre at Waterloo, like the related centre at Montreal, was established with Federal Government assistance to assist the start-up of technology-related firms with the provision of business and technical advice, "seed" venture capital, and low-cost "incubation" space. Educationally, the Centre does provide seminars and workshops to teach the fundamentals of entrepreneurship and cooperates closely with the University of Waterloo in this respect. Numerous individuals and firms have been provided with varying levels of assistance from the Centre, and some of these are now successful.

York University:

The Entrepreneurial Studies Program at York University (Appendix E) is the largest such program in North America and has Canada's first chair in this area (privately funded by Magna International Inc.). At the graduate level the program can lead to an MBA specializing in entrepreneurship. Some 350 students at the graduate level and 35 to 40 undergraduates are currently registered in the program. The program emphasizes "opportunity seeking management" as opposed to the "resource drive" style of management traditionally taught at Canadian business schools, and is oriented to small and large firms applications. While not strictly a "technological"

entrepreneurship program, the program is currently forging close link's with the York Science Faculty (there is no Engineering faculty) in an attempt to encourage the creation of innovative science - and technology-based firms. An enterprise/innovation centre is currently being established, in close association with the program, that will assist students and faculty and attract inventors and entrepreneurs from off-campus. The program is very practically oriented and emphasizes "hands-on" work and the experiences of established entrepreneurs. It is claimed that some 30 new firms per year are now being created as a direct result of the program, and that 25 to 40% of each MBA class is self-employed five years after graduation.

Conclusions:

The following basic conclusions can be made:

- Science, technology and innovation are increasing in economic importance to our society.
- Entrepreneurship, and in particular technological entrepreneurship, is a means of stimulating the commercialization of science and technology, and hence, economic growth.
- Small businesses are increasing in economic importance to our society.
- Principles of technological entrepreneurship can be applied to large and small businesses.
- The latent characteristics of entrepreneurs can be enhanced and encouraged by university-based entrepreneurship studies programs.
- There currently exist, various technological entrepreneurship programs that can provide excellent models, when adapted to local conditions, for the creation of new such programs.

APPENDIX A

THE M.I.T. MANAGEMENT OF TECHNOLOGY PROGRAM

Appendix A

The M.I.T. Management of Technology Program

Massachusetts
Institute of Technology
1984-85

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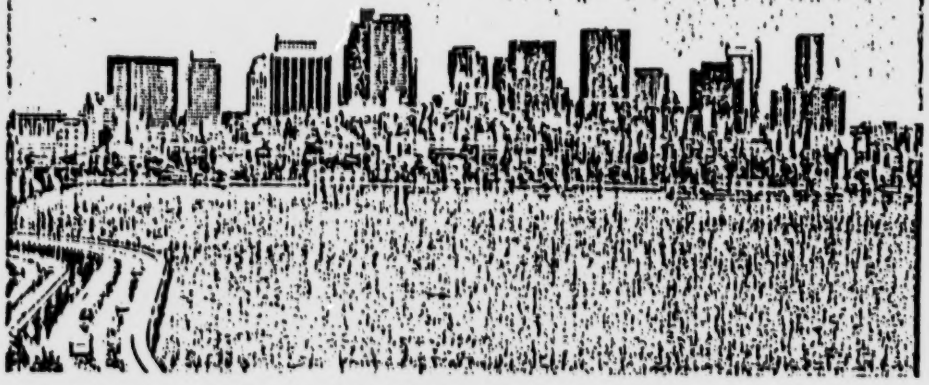
6 Tuition and Costs
7 Financial Aid
8 Collateral Study
9 Teaching Faculty
10 About M.I.T.
11 Other Management Programs

Management of Technology Program
Massachusetts Institute of Technology
Room E52-125
50 Memorial Drive
Cambridge, Massachusetts 02139 (USA)
617-253-3733

The Management of Technology Program was made feasible by generous gifts from the Gillette Company and Pilkington Brothers Limited, which supported the initial curriculum development. Additional corporate donations from Computer Services Corporation (Japan), Corning Glass Works and Rogers Corporation have underwritten the continuing evolution and growth of the Program.

Director — Edward B. Roberts,
David Sarnoff Professor
of Management of Technology

Program Manager — Jane M. Morse



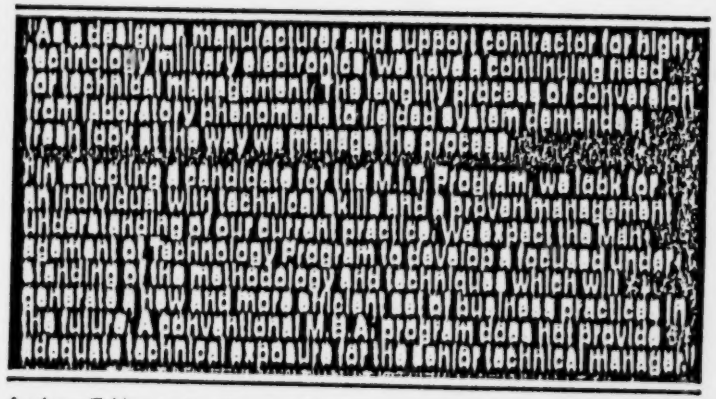
The Boston skyline, as seen from the M.I.T. Sloan School.

The Management of Technology Program at M.I.T.

The Management of Technology Program at M.I.T. is the nation's first advanced degree program focusing directly on the management of technology. Initiated in 1981, it is conducted jointly by the Alfred P. Sloan School of Management and the School of Engineering. The Program leads to a Master of Science degree in the Management of Technology after 12 months of full-time study.

The Program directly responds to the growing worldwide demand of industry and government for managers who can help bring advances in technology to the marketplace in the form of new products and manufacturing processes. In order to successfully cope with the accelerating pace of technological change, today's leaders of technical functions and organizations increasingly require a special managerial perspective, one that was not being addressed comprehensively by educational institutions. To manage effectively, these individuals need more than an in-depth scientific or engineering education and on-the-job experience. They also must possess substantial managerial knowledge in planning and controlling technical projects, directing engineering design and product quality, inspiring and developing professional technical employees, and integrating with the marketing and manufacturing functions of the organization. They require a different education than the general-management M.B.A. type of program can offer.

Precisely this need for a unique combination of technical and management abilities led to the creation of the Management of Technology Program. The curriculum was developed from over 20 years of on-going research at M.I.T. on the management of engineering, R&D and technological innovation. It was designed expressly for scientists and engineers who have been in the field for at least five to ten years, anticipating increasing managerial responsibilities on the technical side of the organization.



Andrew T. Hospodor, *Division Vice President and General Manager, Government Systems Division, RCA Corporation*

Career Focus

The Management of Technology Program is intended for experienced engineers and scientists on a career path requiring increasing responsibility for managing technical activities and technology-based organizations. Its purpose is to provide these individuals with essential management skills and understandings as they progress further into the creation, planning, and control of technical projects and organizations.

Accordingly, the Program's most direct benefits are for individuals who plan for the near future to remain on the technical side of the organization, rather than moving immediately into general management positions. It is expressly structured to prepare them for more senior roles in functional management, where they will be able to both generate and manage technology-based endeavors. Functional leadership in technology management may lead to later career movement into senior general management.

Both company-sponsored and self-supported graduates of the Program have been extremely successful in obtaining increasingly responsible and highly visible positions in technical management upon returning to the workforce. For example, graduates have obtained positions as: Division Director for New Business Development; Manager, Advance Manufacturing Systems; Product Strategy Manager; Chief Project Engineer; and Department Director for Systems Integration.

Student Profile, 1981–1984

Age:	Range	26–53
	Median	33
Years of Experience:	Range	5–24
	Median	9
Education:	Bachelor	47%
	Master	34%
	Ph.D.	19%
Sponsorship:	Organization	47%
	Self	53%
Total Students:		47
Foreign Countries Represented (28%):	Argentina; China; France; India; Japan; Norway; Singapore; Spain; United Kingdom	
Examples of Positions Held Prior to Entering Program:	Technical Director; Project Leader; Research Specialist; Operations Officer (Army); Department Manager; Senior Project Engineer; Product Manager; Physicist; Senior Scientist; Section Head; Test Equipment Engineer; Group Leader	

"A key strength of my year at MIT for me was the association with a core of faculty strongly dedicated to the Program who were deeply concerned about our progress."

Carol M. Lemlein, *Software Manager, Teradyne Inc.*

The Curriculum

The Management of Technology Program admits a limited number of students who participate in a rigorous curriculum developed and taught by faculty from both the Sloan School and the School of Engineering. The courses themselves are structured around three integrated elements:

1. Core subjects in analytic methods and in the disciplines underlying management.
2. In-depth studies on management of technical programs and organizations.
3. An original thesis in the area of the management of technology.

Beginning in June of each year, the curriculum consists of 12 months of full-time study divided into three seasonal terms and culminating in a Master of Science Degree in the Management of Technology. The Summer Term is devoted primarily to a core of subjects in the underlying disciplines that provide a background in general management principles and analytic methods. The Fall and Spring semester curriculum focuses primarily on management principles and issues for managing technological people, programs, and organizations. The Management of Technology Program curriculum thus goes far beyond the standard MBA type of curriculum in addressing specific issues and questions faced by the manager of today's technology-based organization. The current schedule of studies is as follows:

"Living for a year in the Boston area amongst the small and large high-tech firms provides another indirect benefit. Many of these firms have grown up within the last ten to twenty years and exposure to such a fertile business climate changes your business perspectives. This is particularly relevant to overseas students such as myself."

"The Program added a special business dimension to my original technical base. In raw career terms, I'd say the year at MIT has provided greatly increased visibility and enabled me to advance by well over five years."

Charles A. Berry, *New Business Development Director, Electro-Optical Division, Pilkington Brothers p l c.*

Summer Term
Applied Micro- and Macroeconomics
Statistics for Management
Engineering Systems Analysis
Financial and Management Accounting
Current Issues in Management Information Systems
Managing Professionals
Managerial Communications

Fall Term
The R&D Process: Communication and Problem-Solving
Manufacturing/Technology Interface
Cases and Issues in Technology Management
Government and the Management of Technology
Corporate Strategy for Technology-Based Sectors; or Corporate Strategy, Policy and Planning
Choice of Electives

Spring Term
Thesis Research
Marketing/Technology Interface
Corporate Strategies for Managing Research, Development, and Engineering
Choice of Electives

NOTE: Brief descriptions of each of these courses begin on page 8.

"The Program taught me how to integrate technology into a *mature* business. It showed me ways to go after growth opportunities, particularly in new product development."

Henry M. Montrey, *Lumber Technology Manager and Acting Director of the Wood Products Division, Weyerhaeuser Company*

Program Director, Edward B. Roberts.

Eligibility and Admissions

The M.I.T. Management of Technology Program term begins in June of each year only. In the first two pilot years (1981–1982 and 1982–1983) the Program enrolled less than 10 students per year to allow for a developmental period. In the third and fourth years (1983–1984 and 1984–1985), the Program began its expansion, and will take an increasing number of students per year until reaching its eventual goal of 40–50 students per class.

Candidates for admission to the Program must meet the following requirements:

- an undergraduate science or engineering degree;
- a minimum of five to ten years' experience in industry or government as a practicing engineer or scientist;
- completion of formal courses in differential and integral calculus and in macro- and microeconomic theory. (If these subjects have not been completed in an undergraduate program, they must be covered by formal courses prior to enrollment. Review and diagnostic examinations will be given at the beginning of the Summer Term.)

Students are selected for admission by a joint Program Admissions Committee based on its evaluation of an applicant's previous work experience, academic record, and overall qualifications. Applicants are sought who show strong motivation and promise of future career advancement in technology management.

The Program Office seeks registration for each enrollee through either the Sloan School of Management or one of the eight departments of the School of Engineering. (A student's department of registration makes little difference to the student. All enrollees follow the same curriculum and earn the same degree, an M.S. in the Management of Technology.)

All applicants must submit scores from the Graduate Management Admissions Test (GMAT) with their application and should plan to take the October test to meet our application deadline. The GMAT is given several times a year at centers throughout the world, and one must register at least a month in advance. For information on this test, contact the Management of Technology Program Office or write to the Educational Testing Service, Princeton, New Jersey 08540, USA (609-921-9000).

Applicants from non-English-speaking nations must demonstrate proficiency in both oral and written English by taking the Test of English as a Foreign Language (TOEFL). For information about the TOEFL, contact: TOEFL, Educational Testing Service, Princeton, New Jersey 08540 (609-921-9000). A minimum score of 575 is required for visa certification by M.I.T.

Applications for admission must be submitted by February 1 of each year for admission in June of the same year. Contact Jane M. Morse, the Program Manager, for more information and application material.

Tuition and Costs

Tuition for 1984–1985 is currently $20,600. Fees, however, are subject to change from year to year and are expected to rise. The cost of books and personal items should be estimated individually.

Living expenses for one year in the Boston area depend heavily on the needs, lifestyle, and family size of each individual student. As a figure to work from, a single adult may be able to live for as low as $10,000 per year. Some students find living on campus is both convenient and cost-effective. M.I.T.'s Student Housing Office (617-253-5148) can provide information on campus housing for single or married graduate students. A large number of students prefer living off-campus in apartments or houses in the Boston/Cambridge area or in the suburbs. Rental prices and quality of housing vary widely from community to community, so one should contact a real estate agent to help with the search. If a visit to M.I.T. is being planned, schedule a stop at M.I.T.'s Off-Campus Housing Office, in Building E 18, Room 301, for information on available housing for prospective students.

Many employers recognize the value of the Program and may be willing to cover at least part of a student's costs. In previous years approximately half of the Program's students received full support from their firms or government agencies.

The M.I.T. Program has no fellowship funds available, nor does it offer any teaching or research assistantships. However, students who are U.S. citizens or permanent residents are eligible for Federal Guaranteed Student Loans (GSL), generally available through banks. Questions concerning the GSL should be directed to: M.I.T. Student Financial Aid Office, Room 5-119, M.I.T., Cambridge, MA 02139 (617-253-4971).

"Without a doubt, the Program has provided me with the necessary skills to remain competitive in today's high technology environment. All of the curriculum focuses on the development of effective management."

Moises J. Goldman, *Director of Forward Planning, Dukane Corporation*

Courses of Study

The Management of Technology Program offers 15 courses plus a thesis, divided into three semesters. A brief description of each course and schedule follows.

*SUMMER

Applied Micro- and Macroeconomics

Intermediate level subject in micro- and macroeconomics, with special emphasis on applications to managerial decision-making in both the private and public sectors. Microeconomics portion focuses on cost and demand analysis, market structure and industrial performance, design of pricing strategies and effects of government regulation. Macroeconomics portion focuses on the measurement, forecasting, and interpretation of aggregate economic variables, how those variables are affected by government policies, and the implications for management. *Sloan School Faculty.*

Statistics for Management

Introduction to probability and statistical data analysis with emphasis on applications in management. Topics: basic probability, sampling and data collection, exploratory data analysis, inference and diagnostics for linear regression models, statistical computing and simulation. *A. Barnett.*

Engineering Systems Analysis

Synthesis of analytic procedures for identification and selection of optimal systems. Review of economic framework for analysis. Systematic survey of theory and applications of mathematical optimization to engineering problems. Evaluation procedures for single and multi-attributed problems covering utility theory and decision analysis in addition to standard procedures. Application of this material to real problems in planning and design stressed throughout term. *R. de Neufville, J.P. Clark.*

Financial and Management Accounting

Introduction to basic concepts and techniques that underlie the collection, processing, and reporting of financial information in businesses. Emphasis on financial and managerial accounting, with goal of enabling student to understand and use corporate financial statements and internal financial data as a basis for decision-making. *R. Olive.*

*Waiver examinations will be offered at the beginning of the Summer Term for some Summer courses.

Current Issues in Management Information Systems

A seminar designed to address a variety of key topics in the management of information systems. Recent topics have included: critical success factors; trends in software and hardware for decision support; impacts of information systems on individual and organizational performance; expert systems; information systems and strategic planning; legal protection of software; and the protection of personal privacy. *M.I.T. Staff.*

Managing Professionals

Examines human side of management through application of behavioral science research findings. Topics: supervising/motivating professional employees; career orientations; effective conflict management; group creativity/decision making; managing product teams; group aging; critical roles for innovation; organizational structure/communication. Emphasizes professional individuals and groups. *R. Katz.*

Managerial Communications

A seminar in effective written and oral communication for managers. *Communications Staff.*

Program Manager, Jane M. Morse.

FALL:

The R&D Process: Communication and Problem-Solving

Introduces sociology of science and technology, emphasizing similarities and differences between the two activities. Basic problem-solving processes in R&D. Presents research findings of intra- and inter-organizational technology flows. Role of interpersonal, organizational, and architectural factors in affecting communication of technical information. *T. Allen.*

Manufacturing/Technology Interface

Focus on the management of process innovation. Economic and other influences on manufacturing process change. Interactions between research, development, and engineering activities and manufacturing operations. Transfer of new product developments into manufacturing. *J. Utterback.*

Cases and Issues in Technology Management

Study of a selection of issues of great significance to engineers in management, choosing from current areas such as: productivity; biotechnology; energy; technology assessment; information systems and opto-electronics; and government, industry, and university relationships. Case studies involving several real engineering and scientific programs in industrial firms and government agencies to illustrate such important management functions as strategic planning, business development and R&D planning. *T. Lee, R. Pry.*

Government and the Management of Technology

Examination of the changing role of government in shaping and directing the management of technology in the civilian sector of the economy. Principal themes include the rationales, processes, and mechanisms of government involvement; promotion and regulation of technological development and use by government; and industrial policy in the U.S. and other countries. Specific case studies are used to illustrate the themes, for example: protection of individual property, R&D policy, environmental regulation, administrative law. Substantial student involvement in class discussion and preparation are part of the course. *G. Heaton.*

Choice of: Corporate Strategy for Technology-Based Sectors

Considers key aspects of the emerging technology-strategy relationship in the large corporation from different perspectives, including the individual firm, an entire industry, the industrial policy of a nation, cross-country comparisons, and cross-industry comparisons. Uses conceptual readings, empirical studies, case studies, student field studies, and invited outside speakers. *M. Horwitch.*

or: Corporate Strategy, Policy and Planning

Deals with approaches to strategic management problems affecting all facets of the enterprise. Discussions, cases, field studies, and readings trace strategy practice, methodology, and theory. Focus on both strategic formulation and implementation. *Sloan School Staff.*

Choice of Electives

Other subjects are available and suggested for additional elective study in both the Fall and Spring semesters. Examples of elective courses include: Finance; New Technical Ventures; Technology and the Law; Management of Marine Resources; International Technology Transfer; and others.

"I felt a full time program would help me integrate my understanding of how economic and marketing issues drive, and are driven by, technology. The experience has helped crystallize my perceptions in the areas of management style, strategy, and people skills."

Wilbur (Bill) B. Vanderslice, *Technical Assistant to the Vice President of Development and Manufacturing, General Technology Division, IBM Corporation*

SPRING

Thesis Research

All Master's degree students at M.I.T. are required to submit a thesis as part of the requirements for the degree. Program participants are encouraged to integrate thesis studies with on-going M.I.T. research in the management of technology. Sponsored students usually work on research of current concern to their organization and are encouraged to coordinate their research with organizational projects.

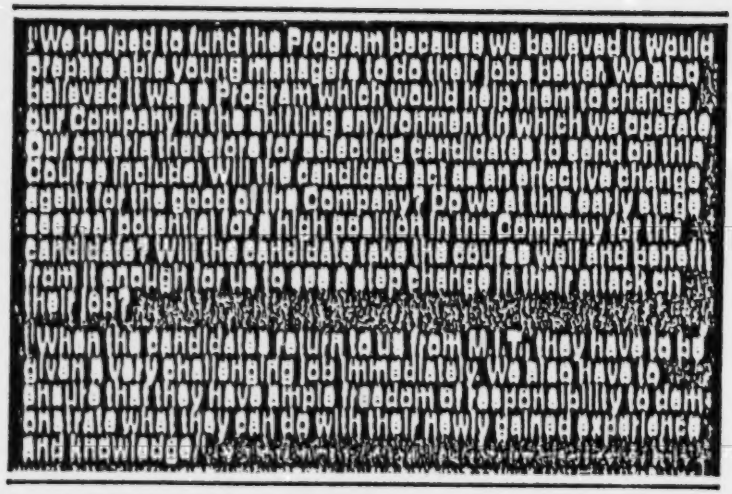
Marketing/Technology Interface

Market inputs to product research, design and development. Market research techniques for new product development in both consumer and industrial areas. User role as source of innovations in industrial goods. Marketing of advanced technology products and systems. *E. von Hippel, G. Urban.*

Corporate Strategies for Managing Research, Development and Engineering

Joint seminar with the Harvard Business School technology management group. Strategic issues in managing research, development, and engineering. Seminar focus changes each year; previous topics have included management of corporate research laboratories, new venture organizations, and integration of RD&E into corporate strategy. Lecture sessions by faculty of both schools and by invited speakers from government and industry. Independent study and preparation of reports by individual students or teams of students. *E. Roberts.*

Choice of Electives


"We helped to fund the Program because we believed it would prepare able young managers to do their jobs better. We also believed it was a Program which would help them to change our company in the shifting environment in which we operate. Our criteria therefore for selecting candidates to send on this course include: Will the candidate act as an effective change agent for the good of the company? Do we at this early stage see real potential for a high position in the company for the candidate? Will the candidate take the course well and benefit from it enough for us to see a step change in their attack on their job?
When the candidates return to us from M.I.T. they have to be given a very challenging job immediately. We also have to ensure that they have ample freedom of responsibility to demonstrate what they can do with their newly gained experience and knowledge."

Dennis S. Oliver, C.B.E., *Director, Pilkington Brothers p.l.c.*

Principal Teaching Faculty

Thomas J. Allen, Jr., Ph.D.
Management of research and development, specifically those aspects dealing with the flow of scientific and technological information; organizational communications; international transfer of technology, and the problem-solving process in research.

Arnold I. Barnett, Ph.D.
Operations research; applied probability and statistics; criminal justice; transportation systems; search theory; public health.

Joel P. Clark, Sc.D.
Applied engineering systems analysis, economic modeling of minerals and materials markets, strategic planning in natural resource industries, substitution among materials, cost of production models of resource industries.

Richard L. de Neufville, Ph.D.
Systems analysis applied to strategic planning and design of engineering projects; decision analysis and optimization; definition of policy issues in technology.

Mel Horwitch, D.B.A.
Corporate strategy especially in advanced technological industries; managing large-scale complex enterprises and project management; energy policy; institutional history.

Ralph Katz, Ph.D.
Management of RD&E professionals and project groups encompassing the general problem of how to maintain group and individual effectiveness over long periods of time; management of organizational careers for RD&E professionals; alternative organizational structures and their effects on project performance; the effectiveness of managerial styles and the management of conflict.

Thomas H. Lee, Ph.D.
Electric power and energy systems; technology assessment; strategy planning; engineering management; R&D planning.

Robert H. Pry, Ph.D.
Electronics, materials, and manufacturing technology; strategic planning and acquisition analysis; product development and technology transfer management; government, industry and university relationships in technology generation and innovation.

Edward B. Roberts, Ph.D.
RD&E management and technological innovation; corporate and social systems dynamics; new enterprises and venture management; health care management and biomedical innovation.

Glen L. Urban, Ph.D.
Quantitative techniques applied to marketing management, design and marketing of new products; preference perception and probability of purchase; marketing strategy, sales force productivity.

James M. Utterback, Ph.D.
Technological innovation in industry; factors which influence innovation including corporate behavior, strategy, and government policy.

Eric von Hippel, Ph.D.
Management of the product innovation process: primarily those early stages in which a "user need" is perceived and a responsive innovation task is specified and undertaken; examination of the ways in which innovators are able to capture benefit from their innovations.

Additional contributors to teaching include:

George R. Heaton, J.D.
Russell W. Olive, D.B.A.
Anthony J. Sinskey, Ph.D.
Kay Tamaribuchi, Ph.D.

About M.I.T.

First opened in 1865, M.I.T. was founded to create a new kind of educational institution—relevant to the times and responsive to the nation's needs—where students would be educated in the acquisition and application of knowledge.

The Institute is an independent, coeducational university, privately endowed. It has five academic schools: Architecture and Planning; Engineering; Humanities and Social Science; the Sloan School of Management; and Science.

The M.I.T. faculty numbers approximately 1000, with a total teaching staff of 1860. The total enrollment is approximately 9350, evenly divided between undergraduates and graduates.

For more information about M.I.T. in general, write for the M.I.T. Bulletin, M.I.T. Information Office, Room 7-111, 77 Massachusetts Avenue, Cambridge, MA 02139.

The Massachusetts Institute of Technology admits students of any race, color, sex, religion or national or ethnic origin to all rights, privileges, programs, and activities generally accorded or made available to students at the Institute. It does not discriminate against individuals on the basis of race, color, sex, religion, age, handicap, or national or ethnic origin in administration of its educational policies, admission policies, scholarship or loan programs, and athletic and other school-administered programs, but may favor U.S. citizens or residents in admissions and financial aid.

Other Management Programs

The Sloan School at M.I.T. offers other management programs in addition to participating in the M.I.T. Program in the Management of Technology:

The Sloan Master's Program offers students the opportunity to build competence in a selected area of concentration, as well as in general management, over a two-year period. It is possible to concentrate in the Management of Technological Innovation by taking three or four electives in this area, while the majority of courses cover other management subjects. Contact Jeffrey A. Barks, Director of Degree Programs, Alfred P. Sloan School of Management, for more information.

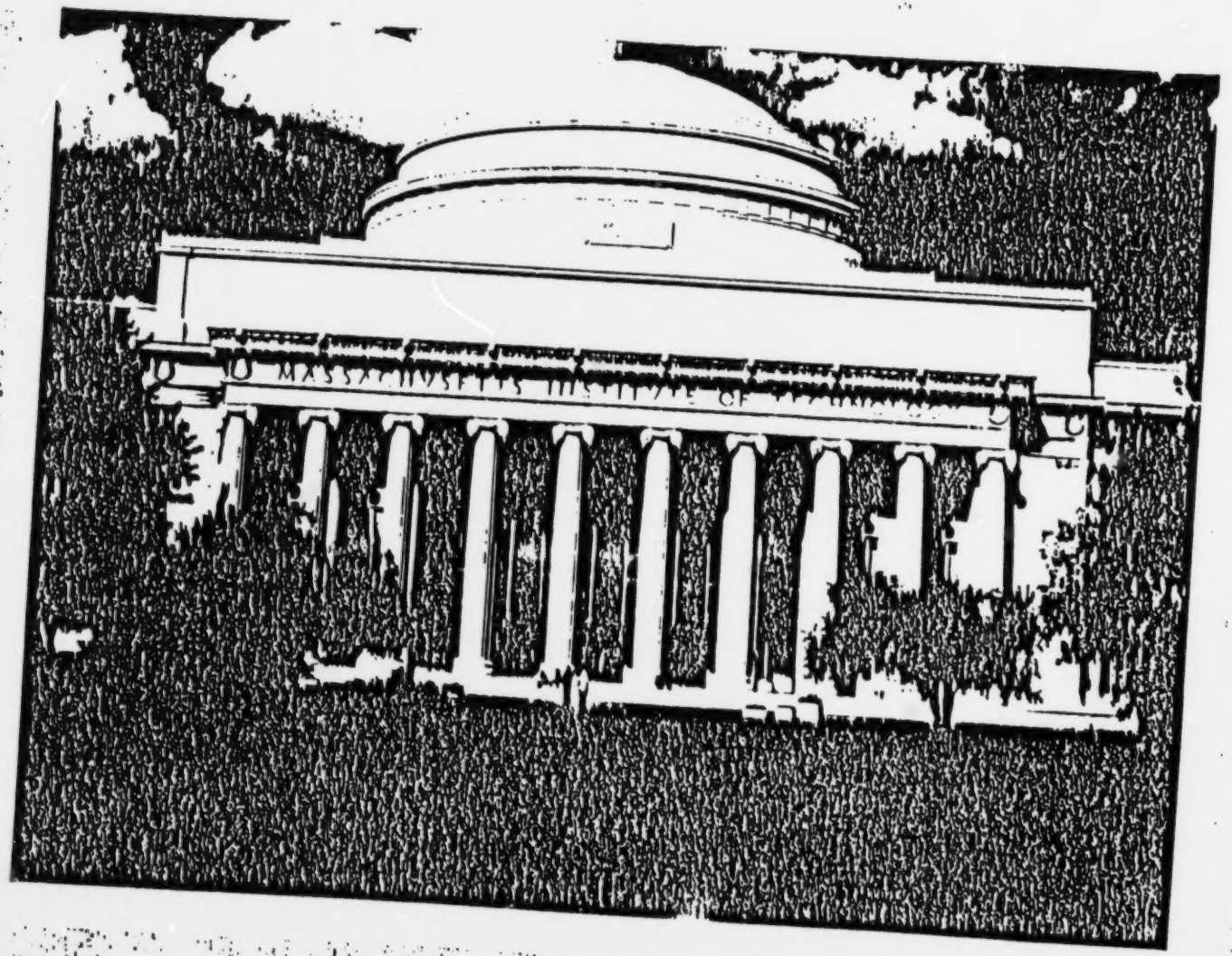
The Executive Education Programs at Sloan are typically for company-sponsored individuals. The Sloan Fellows Program is a 12-month curriculum, which leads to a Master's degree, designed to broaden and develop outstanding but typically specialized mid-career executives for more general and senior management responsibilities. The M.I.T. Program for Senior Executives is a nine-week program of seminar discussions, lectures, reading assignments, and informal discussions with faculty from the Sloan School and the Department of Economics. For more information on the Executive Education Programs contact Alan F. White, Director, at the Alfred P. Sloan School of Management.

APPENDIX B

MIT COURSE ON MANAGEMENT OF RESEARCH, DEVELOPMENT, AND TECHNOLOGY-BASED INNOVATION

June 10-21
Summer Session 1985

Management of Research, Development, and Technology-Based Innovation



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Monday, June 10 through Friday, June 21

Tuition: $3,000 (including daily luncheons)

Technology based innovation consists of two phases of activity—invention and exploitation. The organized "invention process" requires the effective management of research, development, and engineering (RD&E); the organized "exploitation process" requires not only purposeful R&D, but also imaginative management of the linkages among R&D, engineering, marketing, and production. In the United States, over $80 billion are spent annually on RD&E alone, and many times that amount is devoted to the transfer of RD&E results to the market or into the production process. European RD&E expenditures in government and industry are comparable in magnitude. Yet managers of these activities have usually advanced as a result of technical expertise alone and often lack the management training needed for enhancing RD&E performance.

This two-week program provides an understanding of the underlying innovation process, and seeks to improve the managerial skills and perspectives of course participants. The program focuses on the interrelationships among RD&E and the other major organizational functions, including marketing and planning.

Enrollment is limited in order to produce managerial diversity while permitting small group interactions. Preference is given to early applicants with substantial managerial responsibility for technical organizations or for related aspects of the innovation process. Applications should be submitted no later than May 3, 1985.

Two general disciplines support most of the program content: (1) behavioral science concepts that are applicable to the organization and management of individual scientists and engineers, technical groups, projects, R&D laboratories, and engineering departments; and (2) organizational systems analysis and design concepts applicable to the planning, selection, resource allocation, and control aspects of technology oriented programs. Attention will be given to the technological innovation problems of both industrial and governmental organizations. Related marketing and strategic planning issues also will be examined.

The planned schedule for the program includes *lecture-discussion sessions* on the following topics:

First Week
Overview of the process of technological innovation, emphasizing the factors that cause successful commercialization and/or technology utilization

Managing the technical problem solving process, with reference to information sources and uses

Critical staffing functions that must be balanced to assure high RD&E organization productivity

Staff selection, development, and motivation in research, development, and engineering

How to "join up" the new technical employee so as to increase performance and decrease turnover

How organization structure and laboratory design affect technical communication

The role of the technological gatekeeper

Supervising RD&E teams and technical groups

Avoiding the "not invented here" syndrome, while maintaining technical vitality.

Forecasting technological change and its impact

Micro innovation in new product development

Second Week
Selecting and planning RD&E projects

Managing RD&E projects for cost/schedule control and overall technical results

Project, functional, and matrix organizational approaches, and their implications

Managing large-scale programs involving government and industry

Organizing to gain market inputs for industrial goods innovation

Relating RD&E to marketing and production

Increasing the transfer of RD&E results into commercial use

Organizing and managing technical venture programs for corporate diversification

Designing an overall technology strategy, for the firm or government agency

Managing interactions between process and product innovations

Business-government interface on technology transfer

Impact of governmental policy on technological innovation

In addition to morning lecture-discussion sessions, each participant will select several *afternoon seminar series* for more intensive concentration in small groups led by faculty members. Planned seminar sessions for the first week include:

Innovation and industrial revitalization
Managing technical communications
Motivation and leadership in RD&E
Technology planning and strategy

For the second week the following seminars are planned:

Corporate strategy in technological sectors
Market / RD&E interfaces
Process / product life cycles
Technical venture management
Transnational technology movements

Luncheon sessions will be conducted on each day of class in a private dining room of the MIT Faculty Club. Guest speakers at these sessions will discuss new approaches to market research, industrial marketing, and strategic planning that are becoming increasingly relevant for the management of technology based innovation.

Finally, a series of *optional evening "coffee shops"* will engage class participants in discussion and solution of common RD&E and innovation management problems.

Tuition for the Program is $3,000, due and payable upon notification of admission. Academic credit is not offered. The group will meet all day Monday through Friday of both weeks. Luncheon class sessions will be conducted on each day, with the lunch fee included in the Program tuition.

The MIT Technology Management Group

Experience with dozens of major industrial and governmental technologically based organizations clearly indicates that new managerial perspectives need to be added to technical excellence. The MIT Technology Management Group seeks to facilitate the synergy of technology and managerial skills through its various educational programs. These include the new one year MIT degree program in the Management of Technology, which is aimed at mid career engineers and scientists, and this special two-week Summer Session Program.

Since 1961, the MIT Research Program on the Management of Science and Technology has carried out managerial research and education on technology based innovation. Extensive investigation in industry and government, complemented by writing, lecturing, and consulting, have provided the bases for this program. These studies and related activities focused initially on US organizations, but have been broadened in recent years to include Europe, Asia, and Latin America. The ideas have been tested as well by increasing numbers of program presentations in Belgium, Brazil, Denmark, England, France, Holland, Israel, Italy, Japan, Mexico, and Switzerland, and by extensive multinational participation in the MIT Summer Session Program.

The Program is under the direction of Edward B. Roberts, David Sarnoff Professor of the Management of Technology at MIT.

Other faculty and staff of the Sloan School of Management actively collaborate in the program, including Professors Thomas J. Allen, David G. Anderson, Arnoldo Hax, Eric von Hippel, Mel Horwitch, Ralph Katz, John F. Rockart, Denis F. Simon, Glen L. Urban and James Utterback. Visiting lecturers for the program include Alan R. Fusfeld, Vice President and Director of the Technology Management Group of Pugh Roberts Associates, Inc.

Admission: In order to maintain highest standards, the enrollment in each Special Summer Program is limited according to the facilities and staff which are available. If a program is not over subscribed, applications for it will be considered up to one week before it begins. However, early application is strongly advised. Application forms are available from the Director of the Summer Session, MIT. The Institute reserves the right to select those applicants whose qualifications and experience suggest that they will receive the most benefit from the program for which they are applying. Neither admission nor dormitory reservations are transferable except by specific Summer Session Office authorization, and then only when evidence of the qualifications of the proposed substitute has been filed in advance.

Occasionally, it is necessary to cancel a program either because a key faculty member will not be available or because the projected enrollment is too low. Every effort is made to announce such a cancellation at least 3 or 4 weeks before the scheduled start of the program.

The Massachusetts Institute of Technology admits students of any race, color, sex, religion, or national or ethnic origin to all rights, privileges, programs, and activities generally accorded or made available to students at the Institute. It does not discriminate against individuals on the basis of race, color, sex, sexual orientation, religion, handicap, age, or national or ethnic origin in the administration of its educational policies, admissions policies, scholarship and loan programs, and athletic and other Institute administered programs and activities, but may favor US citizens or residents in admissions and financial aid.

The Institute has adopted an affirmative action plan expressing its continuing commitment to the principle of equal opportunity in education.

Payments: Applicants whose admission has been approved will be notified as early as possible and will receive MIT registration cards. Both cards, together with full payment for tuition and housing made payable to MIT, should be returned immediately to the Office of the Summer Session, Room E19 356, MIT, Cambridge, Massachusetts 02139; they must be received *two weeks* before the opening of the program. The amounts of tuition and room rent will be stated in the notification of admission; both may be included in one remittance, and both must be paid in full before the opening session of a program. No bills are sent.

Those whose tuition is to be covered by contract with a government agency or with industry should apply for admission to the Summer Session Office in the usual way, as promptly as possible, noting on their applications that a contract or agency approval is being requested. At the same time they should arrange to have their employer send a purchase order or other evidence of its intention to authorize tuition payments to the Summer Session Office. This purchase order should reach the Summer Session Office at least *two weeks* before the program begins. It should include the full name of the prospective registrant(s), as well as the name of the program. If it is not sent, and if the program is a limited one for which others have applied, the Institute reserves the right to cancel admission. Since housing charges (if any) are not covered by government contracts, these payments must be received independently from prospective registrants at least *two weeks* before the beginning of the program. Please note that a contract or purchase order from industry or a government agency does not reserve a place in a Special Summer Program; it must be preceded or accompanied by a completed application for admission.

Refunds: Registrants who notify the Summer Session Office on cancellation of their plans before they arrive in Cambridge will be refunded their payments. However, no refunds of either tuition or rent will be made to those who arrive late or leave before completing a program in which they have been registered, and refunds of room rentals cannot be made for Saturdays, Sundays, or holidays during a program.

Registration: Each person admitted to a program should report to the main lobby of the Institute at 77 Massachusetts Avenue, Cambridge, by 8:30 am on the day that his or her program begins. At this time he / she completes formal registration, receives a receipt for payments and is given a card of admission to the program. Detailed information about special MIT facilities and services also will be available.

Mail and Messages: Registrants for Special Summer Programs may have mail and messages addressed to them at the Summer Session Office. Please have the name or number of the program included in the address.

Telephone Number (617) 253 2101
Telex Number 92 1473

Dormitory Accommodations: The MIT dormitories on campus will be available to all registrants in Special Summer Programs. Reservations for a single or a double room will be made if specifically requested on the application for admission. Specific room assignments are made upon arrival at the dormitory desk.

The rates in an MIT dormitory for a one week program are: Single room, $140; Double room, $150 from the Sunday preceding the opening of a program to 11 am of the following Friday. Children between the ages of 6 and 14 may be accommodated in the same room as their parents at the rate of $15 for the same period, if specified on the application. Children 15 years or over, are charged the adult / daily rate of $28 per night.

For two week programs the rate for a single room is $336 (adults and children 15 or over) from Sunday through 11 am of the Friday at the conclusion of the program. The double room rate is $360. The rate for children between 6 and 14 years of age, in the same room as their parents, is $36 for the two week period, if specified on the application. Proportionately adjusted rates are based on $20 per night, single; $30 per night, double.

Dormitory reservations will be confirmed in the letter of notification of admission; the latter should be presented at the dormitory upon arrival. Please include payments for dormitory accommodations with tuition payments, both are due at least *two weeks* in advance. Registrants in Special Summer Programs should make rent payments for the regular one- and two-week programs to the Summer Session Office. Anyone wishing to stay beyond Friday may do so by arrangement with the dormitory and should pay for any additional stay at the dormitory desk.

Each dormitory is open 24 hours every day. Children under 8 years of age may not be housed in any dormitory during the Summer Session, nor are pets allowed. No dormitory employee is authorized to modify these regulations.

N.B. Bed linen and towels are supplied. Dormitories do not have private baths. Rooms for men and women may be on the same floor.

Other Housing Accommodations: Applicants who wish other accommodations should correspond with Boston or Cambridge hotels. A list of hotels, motels, and other transient accommodations may be obtained from the Summer Session Office on request.

Dining Facilities: College dining facilities on the campus will be available to Special Summer Program registrants and their guests. Registrants will enjoy guest privileges at the air conditioned MIT Faculty Club. In addition, there are many famous eating places and hotels situated in Cambridge and just across the Charles River in metropolitan Boston.

APPENDIX C

MIT INDUSTRY/INNOVATION CENTRE COOPERATIVE PROGRAM

The Industry/Innovation Center Cooperative Program

INNOVATION CENTER

School of Engineering
Massachusetts Institute of Technology

HE INDUSTRY/INNOVATION CENTER COOPERATIVE PROGRAM

An important aspect of a good engineering education is the exposure of students to realistic engineering problems. A primary objective of the Industry/Innovation Center Cooperative Program is to provide a flux of challenging and market/product-motivated problems for students and faculty in order to enhance the educational experience while simultaneously meeting the specific needs of industrial firms.

The program is not intended to supplant R&D efforts in industry, but rather to augment those efforts by addressing needs and problems that participating firms do not have adequate resources or time to pursue. In order for this endeavor to be most effective, the Innovation Center is seeking to develop stable relationships with a limited number of companies by enlisting these firms as annual subscribers.

The program exposes a member company's needs and problems to a large number of creative students and faculty with broad technical backgrounds and capabilities, for mutual benefit to both the subscriber companies and the Innovation Center. This interaction will yield innovative products and processes for new and existing markets for a relatively small expenditure of industrial resources. In addition, such an educational experience is more closely linked to the personnel needs of the company. Individuals from the member companies benefit as well from exposure to faculty and students at M.I.T.

The National Science Foundation provided a seed money grant to assist in the establishment of this industry/university cooperative program at the M.I.T. Innovation Center.

Program Features

- The number of member companies will be limited, with no more than one company in a particular product area being a subscriber at any given time.
- Industrial participants will be companies which provide an annual fee for program support. New subscribers make an initial two-year commitment.
- Member companies will provide a flow of needs and interesting problems to the Innovation Center. It is estimated that four or five problems from each company each year will allow the program to operate at a suitable level of activity.
- Member companies will be encouraged to send several of their best people to the Center for a few days during each academic term to interact with students and faculty.
- New faculty will be drawn into the program when specific areas of interest are identified. As solutions to various needs are generated, proposed project work will be presented to the appropriate member company. Each member company will have at least one project underway, after an initial start-up period. If specific projects require additional support from a member company, this funding will be requested before a project is instituted. Work leading to graduate and undergraduate thesis research is encouraged.
- The output of the program is newly-developed products and product concepts which can be integrated into the product lines of the subscriber companies. These companies have rights of first refusal for products developed at the Center in response to the needs and problems they have submitted.

The Innovation Center

In 1973, M.I.T. established the Innovation Center under a cooperative agreement with the National Science Foundation to develop an experimental innovation education program and to encourage those students who wish to become innovators or entrepreneurs. The Center's objective is to provide supplemental education on a wide variety of topics within the technological innovation process in order to prepare students for successful careers as industrial leaders.

Traditionally, engineering education has emphasized basic science and well-defined engineering disciplines, with research and design optimization. The Innovation Center builds upon these basics and provides an educational program which enhances ability to synthesize novel engineering configurations and to develop concepts into marketable products. Emphasis is placed upon recognizing and manipulating dominant technical parameters that cut across the various engineering disciplines and on understanding the basic building blocks of design configuration within the context of industrial management systems.

The Innovation Center is organized within the School of Engineering to serve students throughout M.I.T. The Center pursues its goal of increasing student awareness of career possibilities in technological innovation and entrepreneurship through both classroom and laboratory activities. The faculty members associated with the Center have a wide variety of backgrounds and interests and the Center is able to attract additional faculty from throughout M.I.T. for participation in projects related to their own specialties.

Educational Program

The entire innovation process is highly complex, encompassing a broad spectrum of activities including the recognition of a need and the generation of an innovative solution to meet that need, the establishment of a stable market for the new product, and all of the various steps which come in between these end points. Various skills are required, not the least of which is an understanding of how the elements of the whole process must fit together to be successful.

The Innovation Center is focusing on the development of methodology for understanding and teaching the technological innovation process. In addition to classroom teaching, a large part of our educational program is hands-on, student participation in the innovation process. The cooperative program described in this brochure provides the Center with excellent, authentic projects for this valuable "teaching hospital" experience.

Past Developments at the Center

The Innovation Center has had considerable experience in the conception and development of new, marketable products, and a number of these projects have been sponsored directly by industry. The products have been in a variety of technology and market areas, indicative of the wide range of capabilities and interests of the Innovation Center faculty and students. Some of these products are listed below:

- 3-D Display: A new concept for the presentation of real, three-dimensional, computer-generated images.
- Powered Wheelchair System: An improved, high performance wheelchair drive and control system.
- Automated Inspection System: A prototype system for high-speed measurement of ground metal surface roughness.
- Precious Metal Detector: A low-cost, automated device for the non-destructive determination of the quality of gold bullion.
- Infrared Communication System: A high quality communication link for high fidelity music for use with cordless headphones.
- Heating, Ventilating, and Air Conditioning Control Systems: A highly cost-effective, microprocessor-based controller for networks of HVAC units in medium-size buildings.
- Herpes Simplex Inactivator: A device which delivers controlled charges, in combination with other elements, for inactivation of herpes simplex virus.
- Blood Gas Detector: A device for measurement of P_{O_2} and P_{CO_2} both *in vitro* and transcutaneously.
- High Efficiency Archery Bow: A revolutionary, new bow which permits holding at the fully drawn position with little force, without the use of pulleys.
- Tennis Racket: A new racket concept which permits the player to "feel" a larger "sweetspot" and thus play more accurately and with greater comfort.

Becoming a Member

Membership in the Industry/Innovation Center Cooperative Program is open to those firms which can benefit from the innovative resources of the Innovation Center. The Center is seeking to identify such firms to participate. Companies wishing to learn more about this opportunity should contact:

Professor David G. Jansson
Director, Innovation Center
Building W91-209
Massachusetts Institute of
Technology
Cambridge, MA 02139
(617) 253-6946

INNOVATION CENTER - 50 -
BUILDING W39-201

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
CAMBRIDGE MASSACHUSETTS 02139

NOV 27 1974

Brief Description of the Entrepreneurship Class

I. Material presented

The Entrepreneurship class contains three major sections:

A. Lectures

B. Case discussions

C. Guest lectures by entrepreneurs

A. The lectures present important material relating to the fundamentals of new high-technology business ventures, such as: how to evaluate ideas, business opportunities, and on-going companies, new product marketing, the importance of design, legal forms of business organization, and patents and licensing. Lectures are presented by the faculty member in charge, with a few additional guest lecturers such as an attorney, when appropriate.

B. The case discussions in class provide learning opportunities through the mechanism of situation analysis and group interaction. Cases used are from Harvard Business Case Services and from the text:

Liles, Patrick R., New Business Ventures and the Entrepreneur, Richard D. Irwin, Inc., 1974

C. During the semester, a few guest lecturers who are entrepreneurs are invited to present their experiences to the class and to answer the questions of the students. This activity brings realism and confirmation to the concepts previously presented.

II. Student work

This subject is principally a project-oriented subject; that is, the primary grading instrument is a major term project done by groups of two or three students, for presentation, oral and written, at the end of the semester. Several of the homework assignments are used to ensure that the students get started early enough on the project, a complete business plan for a new venture.

A programmed learning text in accounting (given below) is assigned at the beginning of the semester as the first assignment. Class time is not used for presentation of accounting material.

Anthony, Robert N., Essentials of Accounting, Addison-Wesley, latest edition

Two quizzes are given during the semester, a case analysis (take-home quiz) and a quiz on accounting and financial analysis (also a take-home quiz).

Other student work includes case preparation and reading assignments.

INNOVATION CENTER
BUILDING W39-201

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
CAMBRIDGE, MASSACHUSETTS 02139

Brief Description of the Invention Class

I. Material presented

A. Technological innnovation process and how invention fits.

B. Parameter analysis (invention methodology)

C. Invention evaluation

D. Patents and licensing (brief)

The class format is largely workshop oriented, with some lectures on fundamental material such as methodology and patents. Case discussions and group problem solving are stressed.

II. Student work

The students invent a new device to meet the requirements of a specific high-tech market need. Students work in groups of 2 or 3 and are expected to carry out critical physical experiments or build proof-of-concept models. Initial market impact is also considered, along with an initial plan of development. Emphasis, however, is on the parameter analysis approach to invention.

Several homework assignments relating to the invention process are used early in the semester to help to focus on the individual elements of the process. In addition, students are required to prepare for workshop sessions.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
CAMBRIDGE, MASSACHUSETTS 02139

INNOVATION CENTER SUBJECT OFFERINGS

2.941J Invention

(Same subject as 10.802J, 13.77J, 16.671J)
Prereq.: Permission of instructor
G (1)
3-0-6

Analyzes invention process. Presents methodology for invention. Topics: 1) observing technology; 2) analyzing needs; 3) indentifying critical parameters to trigger potential solutions; 4) creative synthesis based on key parameters. Also patents, licensing, and marketing. Requires term project. Students work on inventing to meet needs of their own choice as well as those from companies belonging to the Innovation Center's industry program.
D. G. Jansson, A. D. Carmichael, W. R. Markey, J. P. Longwell

2.944 The Idea/Product Transformation (New)

Prereq.: Permission of instructor
G (2)
3-1-5

Project-centered subject addressing transformation of new ideas into technology-based products, attaining a proper match between product and marketplace, from the perspective of both source and customer. Product design issues: evaluation, market perception, aesthetics and human interfacing, design for manufacturability, reliability, and repairability, pricing, and legal implications.
D. G. Jansson, W. C. Flowers, W. P. Seering

Entrepreneurship

Offered under: 2.942, 6.936, 10.801, 13.78, 16.672, 22.86
Prereq.: —
G (2)
4-0-5

Introduction to various issues faced by technical innovators/entrepreneurs. Topics include concept evaluation, patents and licensing, financing, marketing, business planning, accounting, and team building. Case studies are used. Term project required in which student ideas are developed into business plans. Open to undergraduates by permission of instructor.
D. G. Jansson

APPENDIX D

CANADIAN INDUSTRIAL INNOVATION CENTRE
WATERLOO

The Canadian Industrial Innovation Centre/Waterloo

C. Frank Phripp*

INDUSTRIAL TECHNOLOGY CENTRE

INNOVATION has become a fashionable word in today's society. It is intended to connote merit in originality. When used in the technological sense Innovation has been assigned additional meaning to distinguish it from invention and to imply special commercial value. A technological innovation is usually expected to possess not only the technical novelty of an invention but also to promise profitability in the market place. The latter distinction is a significant differentiating characteristic in that the profitability performance must be demonstrated to be believed and such demonstration readily assigns the worth of the innovation.

This interpretation of technological innovation is needed to appreciate the role of the Innovation Centre "to increase the quantity and improve the quality of technological innovation in Canada". Thus the Centre is vitally concerned with the results of scientific and engineering research and with inventions. But it approaches such developments from a particular point of view — how may the results be put in the marketplace profitably? With this perspective predominant it is apparent that the Innovation Centre cannot be a group of laboratories and workshops. Rather it is people who are knowledgeable over a broad range of technologies and skilled in the disciplines of their application. The Centre applies expertise in technical development, test and demonstration, evaluation, market analysis, patenting, licensing, marketing, business planning, new venture start-up, financing and investment. Thus the Centre's principal task is the systematic application of these skills to a series of innovations to produce a profitable result.

The concept is disarmingly simple: the execution is alarmingly hazardous — in the senses of both commission and omission. Does one commit many resources to a project only to discover it is worthless? — or does one withdraw from an idea that later can be shown by greater efforts to be priceless?

To complicate the situation it must be recognized that it is frequently difficult and sometimes impossible to determine first of all the feasibility and then the profitability of an idea by any means short of actually doing it. How could anyone accept the notion that man could fly in the sky and then conclude that great numbers would pay to fly? And now we ponder the same questions in relation to space travel! Fortunately we find ways to divide the tasks of innovation into subdevelopments containing manageable amounts of uncertainty. However, it is this notion of management of uncertainty on behalf of profit-seeking shareholders that exerts one debilitating influence on innovation. Risk is avoided by withdrawing from the uncertainties of technological innovation. Thus, in some sectors, including Canadian industrial and financial communities, technological innovation lags behind that occurring elsewhere and fails to exploit many potentials within emerging technologies. The Innovation Centre represts one attempt, a highly pragmatic effort, to deal with such deterrents to technological innovation.

Some techniques practised by the Innovation Centre may illustrate how it endeavours to accomplish its function. First, the Centre's doors are always open to receive any and all inventions from any source. They are first examined by a systematic two-stage evaluation procedure. Since experience dictates that there are many more ideas than successes, the Centre first checks each idea against a set of established criteria for success. If this first test is passed, the idea is subjected to more penetrating scrutiny by people well-qualified in the field of the invention. This is clearly a task that must involve expertise beyond that of the small staff of the Centre. Accordingly, the Centre has been assisted by more than two thousand evaluators whose competence spans the technologies of all 1680 inventions assessed in the seven year life of the programme. A computer-based file which is efficiently accessed on the basis of technology interests is an essential instrument for effective invention evaluation at the Centre.

The above relatively inexpensive invention filtering process has selected 25 per cent potential successes from all the ideas that enter the system initially. However, at that point the selection process is not complete and the additional efforts to find the expected one to three per cent actual successes include development activities and become more expensive. These additional activities may involve technical and commercial development, testing, prototype construction, market analysis, patenting, and planning of commercial exploitation whether by licensing to an existing industry or launching of a new enterprise. In return for its efforts, the Centre takes some share of equity or royalty that derives from the invention, thereby reducing the initial investment required by the inventor, while putting the development on a sound and credible basis.

Another important activity of the Centre is its assistance to entrepreneurs in establishing new enterprises. New ideas of significant potential are often best launched by means of a new venture created for the purpose. However this presents problems with which the technical entrepreneur is totally unfamiliar and which are severe even under most favourable circumstances. The Centre will join with the entrepreneur to provide certain services, to advise and to assist in some of the more difficult tasks such as planning of the business including marketing and raising capital. Again the Centre takes a small share of equity in the business, and sometimes fees for some services, in return for the assistance rendered.

Two subsidiary operations of the Innovation Centre provide important support for the entrepreneur. The first is Technology Development Incorporated which provides seed capital for new enterprises. It is a vehicle which enables investors to make investments in early start-up companies with promise. It also provides that essential early money that is difficult for entrepreneurs to find on their own. The second subsidiary operation is Innovation Place Incorporated, our "Place to Succeed". It provides office and light assembly space, telephone, and furniture, secretarial, receptionist and word processor services as well as a variety of additional optional services to the entrepreneur in the early start-up stage of the company. Innovation Place provides its clients with a good business image and a supportive environment from the day they move in. Located near the Innovation Centre, the clients are easily able to access the other services the Centre provides. This operation has been very successful; it has "graduated" several clients who needed to expand to larger quarters. The Centre is currently planning replication of Innovation Place in other communities.

Supporting the invention and new enterprise activities of the Innovation Centre are two important functions, finance and marketing. Good financial planning and management is based on accurate record-keeping in a system suited to the business, and clients of the Centre are guided and assisted in adopting such good practices. Marketing analysis is important for the Centre and its clients in assessing the potential of projects and drawing up plans for marketing the results.

Additional activities of the Centre include accessing government assistance and undertaking contracts for industry to enable development of innovative products and services. Educational services provide workshops and seminars on innovation topics. A research programme assists academic faculty to pursue topics investigating various aspects of the processes of technological innovation in Canada.

The Innovation Centre expanded to its present form in 1980 and already it has a number of accomplishments to its credit. Several inventions have been licensed,

continued on page 12

SSHRC Annual Report — Highlights

The Social Sciences and Humanities Research Council spent $51.3 million for grants and fellowships in the humanities and social sciences in 1982-83 compared with $42.2 million the year before — an increase of 21.8 per cent. This increase represents, in large part, supplementary funding provided by the government for stepped up research in Canadian studies and priority areas.

In his preface to the Council's annual report, presented to Communications Minister Francis Fox, president Dr. William E. Taylor, Jr., notes that the agency's budget falls far short of meeting the needs of research in the important human science disciplines, which now number about 50 within the Council's mandate. The human sciences constitute "the core of the university experience," Dr. Taylor says. He estimates that among all the scholars in Canada eligible for Council grants (numbering about 41,000 in 70 institutions), the per capita share of the Council's budget works out to scarcely $1,300. "Such a low figure helps to explain some of the client hostility and some of the weaknesses that continue to beset national work in the humanities and social sciences."

In reviewing the Council's activities for the year, Dr. Taylor sees the programmes for research training, research support and research communication as important not only to the community of scholars but also to the general public. The people of Canada benefit in myriad ways from the work of the human science specialists receiving public funds, Dr. Taylor says, not least in helping to point ways of "maintaining a humane balance in a world obsessed with technology."

There is a need for substantially greater government allocations for social sciences and humanities research. "Council statements make strong cases by presenting evidence of the intensely relevant and fundamental work the Council supports. A measure of this relevance is to be found in our annual report."

Following are some of the report's highlights.

Fellowships for research training and research support are the biggest single item in the Council's budget, accounting for over $17 million in 1982-83. Recipients were doctoral students ($10 million), master's degree students ($1 million), postdoctoral scholars ($2 million) and university scholars receiving research fellowships while on leave ($4 million).

The doctoral fellowships programme is the largest, supporting over 1,100 students last year with stipends of up to $9,720 each plus a travel allowance.

Research Grants to individuals and groups totalled $15.5 million last year, compared with $11 million in 1981-82. Over 800 grants were awarded, ranging over some 50 disciplines.

Major Research Grants, formerly called "negotiated grants" because the shared-cost budgets are negotiated with the sponsoring university, support such large projects as the Dictionary of Canadian Biography, the Collected Papers of Louis Riel, the Historical Atlas of Canada, and the first critical editions of "classics" in Canadian literature in English and French. Last year the Council spent over $5.5 million on 23 of these projects.

Strategic Grants support research on themes and areas of national importance, chosen by the Council in consultation with the research community. Expenditures for all Strategic programmes totalled $6.4 million in 1982-83 compared with $3.7 million the year before. The largest amount was awarded for work in population aging, at $1.5 million, followed by research tools for Canadian studies, at $1.4 million. Management studies took up $1.2 million. Projects on the human context of science and technology, and the family and the socialization of children received $274,000 and $525,000, respectively. University libraries received $770,000 and small universities $437,000. Notable among the projects funded last year were two gerontology research institutes at the University of Toronto and the University of Guelph, and a Canadian fertility pattern study based at the University of Western Ontario.

Research Communications programmes, which include grants for scholarly publishing, learned societies and scholarly conferences in Canada, recorded expenditures of over $4.6 million last year, compared with $4.3 million in 1981-82. The number of learned journals receiving assistance grew from 106 in 1981-82 to 115 last year, conferences from 135 to 158 and scholarly manuscripts from 170 to 180.

The latter programme, which is administered by the Social Science Federation of Canada and the Canadian Federation for the Humanities, using block grants supplied by the SSHRC, produced an impressive list of titles in fields such as politics, economics, law, linguistics, classics, history, and literature, by well-known Canadian scholars.

International Relations programmes awarded grants totalling some $1 million last year, compared with $800,000 the year before. These funds go toward travel costs for Canadian scholars participating in international conferences or serving on the boards of international organizations. They also assist cooperative research on international projects. Canadian scholars invited to lecture abroad or foreign scholars invited by universities here.

The Council awarded 162 grants last year to Canadian scholars taking part in foreign conferences. Ten Canadian universities brought foreign lecturers to Canada with Council help, and 14 Canadian scholars went abroad for lecture tours on subjects ranging through Canadian literature, politics, education, history, social work and international relations.

The 240-page report is bilingual and lists all individuals and organizations awarded grants in 1982-83, with supporting statistical and financial tables. The text discusses programme highlights and administrative changes over the year, and in the programme areas gives brief descriptions of representative projects. Copies of the report may be obtained from the Information Division of the SSHRC, Box 1610, Ottawa K1P 6C4.

Innovation

continued from page 15

some are already in production and on the market. A number of companies have been started and some have expanded to several employees and appear to be well on the way to becoming profitable ventures.

The experience of the Centre to date confirms the assessment of its founders at the University of Waterloo and in the Federal Government that direct service assistance in technological innovation will increase the quantity and improve the quality of technological innovation in Canada. We anticipate more good results in the years to come.

Further information may be obtained from C. Frank Phripp, C.E.O., Canadian Industrial Innovation Centre/Waterloo, 156 Columbia Street West, Waterloo, Ont. N2L 3L3. Tel. (519) 885-5870.

**C. Frank Phripp is Chief Executive Officer of the Canadian Industrial Innovation Centre.*

Education . . . acquiring the skills of successful innovation

In the field of innovation, technical knowledge is not enough . . . successful innovators must also know how to turn their ideas into profit, a process which requires a set of skills and expertise beyond those required for invention.

Through its education activities, the Centre provides a number of programs and resources to help innovators acquire these non-technological, but essential skills.

"The process of technological innovation is the heart of the basic understanding which the competent manager, the effective technologist, the sound government official and the educated member of society should have in the world of tomorrow." **James Bright, The Industrial Management Centre**

The Education Department has the responsibility for:
- **preparing and delivering instructional programs**
- **creating teaching aids and materials**
- **identifying hands-on experience opportunities**
- **providing assistance to Canadian educators in innovation related areas.**

The Centre's educational programs are made available to the public through seminars and workshops. These are provided both for independent innovators and those working within industrial organizations. Courses and seminars can also be provided on an in-company basis.

Representative topics for these programs include:
- **Financing the New Technological Business**
- **Patenting Your Invention**
- **Launching a Technology Venture**
- **Entrepreneurs' Workshops**
- **Developing Your Innovation**
- **Implications of New Technology on Intellectual Property Administration**
- **Marketing Your Invention**
- **How Much is Your Patent Worth?**

Student Innovations

The Centre believes that today's students will be the major source of tomorrow's innovations. We actively participate in programs designed to prepare young people for their future roles as technical innovators and entrepreneurs.

- ***Waterloo Enterprise Program:*** **Guidance to students in the planning and development of inventions and business ventures.**
- ***Ontario Engineering Design Competition:*** **Support of and participation in this annual event.**
- ***Waterloo Centre for Creative Technology:*** **Support to this summer school program for gifted high school students.**

The Snowblower

Arthur Sicard was a Quebec farm boy who saw the possibility of adapting mechanical ideas developed for harvesting grain to the problems of snow removal. His invention combined a rotary cutting and gathering mechanism with a blower and chute to direct snow either into a truck or to the side of the road. The first production model was tested on the streets of Montreal in the winter of 1925. It was a success and word of Sicard's machine soon spread to other Quebec municipalities. Before long, orders began to come from other parts of Canada and the US, and a new industry was born. Today SMI, the successor to Sicard's original company, manufactures and sells snow removal and other types of equipment for use on streets and airports all over the world.

Research . . . probing the innovation process

Closely linked with the Centre's Education Department, the Research Department has been created to stimulate and conduct primary research into innovation processes and entrepreneurial functions.

Research is needed to gain a better understanding of the factors influencing technological innovation and to provide insight into what might be done to improve innovative performance in the Canadian situation.

"Always remember that someone somewhere is making a product that will make your product obsolete".

Georges Doriot, American Research & Development

This knowledge is seen as an essential aspect of the Centre's work in providing leadership to the innovation and entrepreneurial communities in Canada.

As well as making use of this research itself, the Centre makes significant findings available to the educational and business communities through the publication of results.

"If man look sharply and attentively, he shall see the future; for though she is blind, yet she is not invisible". **Francis Bacon**

In this way the Centre will provide a reliable source of information serving the following specific purposes:

- regular freshening and updating of educational programs, courses and materials developed by the Centre.
- provide understanding of the factors which promote successful innovation in order to enhance the Centre's ability to assist in this process.
- discover remedies to factors which inhibit the commercial development of new inventions and start-up of new technology-based businesses.
- provide a data base from the experience of the Centre to enable future ventures to be analysed against established criteria.

For details of specific research programs, grants, etc., contact the Centre.

Insulin
Banting and Best are well deserving heroes of Canadian medical research for their work in discovering insulin and developing its application in treating diabetes. Less known is the continuing role played by Canadians in the development of insulin technology. An excellent example is the experimental insulin pump, a self-contained portable apparatus which takes over the task of the pancreas in regulating the flow of insulin into the bloodstream and thus removes the need for self-administered injections by diabetic sufferers.

APPENDIX E

YORK UNIVERSITY ENTREPRENEURIAL STUDIES PROGRAM

Appendix E

UNIVERSITY AFFAIRS
January 1985

Honing business skills at York

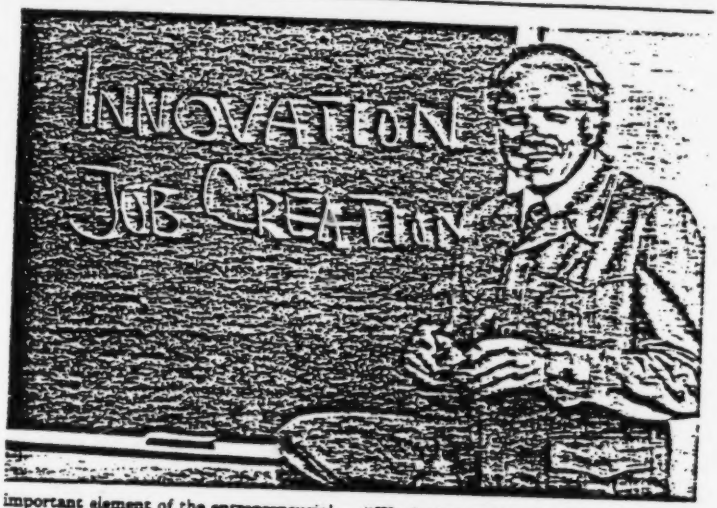
Valerie Shore

We've all seen them — the old movies where the down-on-his-luck but enterprising young man stumbles onto the business opportunity of a lifetime. Using sheer grit and uncanny business savvy our hero then single-handedly forges a corporate empire and eventually sails off into the sunset to live happily and wealthily ever after.

Unfortunately for most of us, real life hardly ever follows such scripts. Rarely is the road to success that straight. If our hero were in Canada today, however, one way of improving his chances would be to enrol in York University's entrepreneurial studies program.

Billed by the university as the largest such graduate program in the world, the 12-year-old program combines academic training with extensive interaction with the small business and entrepreneurial sectors in Canada. The end product is a specialist trained to understand, manage, start-up and/or advise small business operations.

"This is a unique and very comprehensive program", says its founding director, Rein Peterson. "Other Canadian universities might teach one course, maybe two, but not comprehensive like ours."



Popular courses

The entrepreneurial studies program is the largest of several special programs leading to an MBA from York's faculty of administrative studies. It is also one of the most popular.

"Every year I go out of my mind trying to figure out how to get everybody into all the courses", says Dr Peterson. At present about 130 people are registered in the entrepreneurial studies concentration.

Courses cover the gamut of entrepreneurial activity, from new venture formation to managing a small business to acquisitions, mergers and divestitures. The requisite introductory course in entrepreneurship and small business examines the nature of the entrepreneur: why they do what they do and why they're so important to the economy.

"We define small business and entrepreneurship as owner-managed businesses", notes Dr Peterson. "Small is a generic term."

The popularity of the program has been its trademark since it began with a single seminar course in how to start a business. As interest grew, other courses followed and then a grant from the provincial government helped finance the creation of the York Enterprise Development Centre, a student-run, small business consulting service. The centre now acts as an important element of the entrepreneurial studies program.

"The centre is like a practicum", says Dr Peterson. "Students actually work in the field and help solve business problems. It really helps build up their confidence."

An increasing interest in the program in recent years has been largely due to the unemployment situation. People can't get jobs, so they have to create their own, says Dr Peterson, adding that this is particularly true during a recession.

"More businesses get started in recessionary times than at any other time. People get laid off or fired and they're forced to do something with their lives. So they start businesses."

Also, during a recession there is considerable readjustment going on in the economy, meaning more opportunities, he says.

"In fact, one of the ways you pull out of a recession is that new ideas, new products and new companies are established, which then bring us into the next cycle."

Ultimate 'widget'

According to Dr Peterson one of the most common mistakes made by aspiring entrepreneurs is not going to other people for advice. Too many try to go it alone.

"The entrepreneurs that tend to have trouble are the ones who are very withdrawn into themselves and are product-oriented. They like to produce the ultimate 'widget' with golden knobs, bells and whistles, but nobody wants to buy it."

The successful entrepreneurs, on the other hand, are the ones who are good at listening, checking things out with everybody and building their own personal people networks. This is what the program teaches, he says.

"We don't turn somebody who is not an entrepreneurial person into an entrepreneur", says Rein Peterson, director of the York program. "We just take the skills they were born with and improve on them."

"We hone their skills and we actually train them a bit. We don't turn somebody who is not an entrepreneurial person into an entrepreneur. We just take the skills they were born with and improve on them, develop them."

Just how successful graduates of the program are has not yet been precisely measured. However, about 40 per cent of all York MBA graduates report that they are self-employed after five years.

"These findings are corroborated in other schools like Harvard. We figure we're just as high on that score."

Not all graduates choose to start up their own business. Some work for small business, or enter their family business. Others take managerial positions within large organizations that deal frequently with small firms. Still others work as entrepreneurial managers in large corporations undergoing organizational renewal.

Research

The entrepreneurial studies program

York, Fac. Admin. Studies.
(416) 667-2532.

also has a strong research component. At the centre of it is Canada's first chair in entrepreneurial studies, funded by Magna International Inc., one of the largest manufacturers of automotive parts in North America.

Established in late 1983, the chair has enabled its first holder, Dr Peterson, to tie together a number of research projects on Canadian management practices. Some of these studies are on Magna itself.

"Magna is an organization that is unique in many ways", he explains. The company has up to 65 plants, called divisions, each run like a small business. In addition, the division manager has a large amount of autonomy and is able to act very "entrepreneurially" in a large corporation context.

"This is very unusual and we believe that it explains why Magna has been growing at 35 per cent per annum for 12 years. This year it is going to grow at something like 60 per cent in terms of revenue and profit."

Last year Dr Peterson and a research fellow surveyed 15 of the plants and compared them to standard measures of a small business.

"We've defined something called an 'intrapreneur' — an entrepreneur within a large organizational context. There are some differences but they're not as large as we had originally thought."

Another project, which will use some of the Magna data, is one being funded by Shell Canada on "emerging managerial competencies". In essence, the study is looking at what is happening to the kind of skills required to run large organizations.

"What we're finding is that large corporations have to become more entrepreneurial in the future. They've become flatter organizations — middle management is contracting out."

Being entrepreneurial, says Dr Peterson, means that you're interested in making change — you're not maintaining things that have been the same for years and years.

"What's been happening is that we've been training managers for years to be basically trustees of some investment that somebody has put into a corporation. All they are supposed to do is earn a fixed rate of return."

This is no longer acceptable, he says, noting that corporations are now putting more emphasis on opportunity-seeking.

"I call that entrepreneurial — to be able to see an opportunity, to know what to do about it and how to act on it. It involves change, it involves behavior that is different from what you've been doing in the past."

Science faculty

Another interesting project involves an agreement soon to be signed with York's faculty of science in which students in the entrepreneurial studies program will help faculty members commercialize their research and start new businesses.

"Until now we've dealt primarily with non-technical ventures because we didn't have the link with the science faculty", says Dr Peterson.

"We can't look at an invention and decide whether it violates the second law of thermodynamics or not. We don't have the skill."

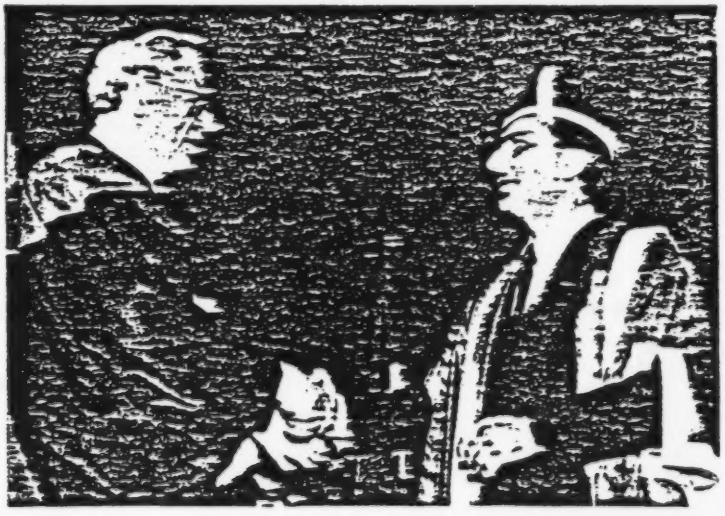
What they can do, he says, is tell the faculty member whether the product has a market, about financing and the legal and tax implications. Then they can set up a business plan.

"We could even give them a couple of students to work with until the enterprise gets off the ground."

Courtesy McGill University

Moving into the technology side of venture formation is a long overdue step, says Dr Peterson, noting how everyone these days — universities, government and business — is anxious to bridge the so-called "gap" between academe and the business community.

"I'm very enthusiastic about this because it is something that I've been trying to do for years — get people together. Now I've got them all together. So far, so good."



J. Francis Leddy (left), president of the University of Windsor from 1964 to 1978, offers congratulations to the university's new president, Ronald Ianni. In his address Dr Ianni said that universities must be committed to a more contemporary model of the university graduate. "That is, a person educated for insecurity, who can innovate, improvise, solve problems with no precedent."

New programs to promote university-business links

Ontario universities looking for help to bring new technologies to the marketplace can now draw on two recently established assistance programs sponsored by their provincial government.

The Ontario Ministry of Colleges and Universities is administering a $30 million university research incentive fund (URIF) designed to subsidize joint university-business ventures.

The fund, announced in the Ontario legislature in November by Bette Stephenson, Minister of Colleges and Universities, provides for the government to contribute one dollar for every two dollars invested in a university research project by a corporation.

The stated goal of the fund is to promote research projects "which have potential economic benefit for Ontario and which strengthen the partnership between industry and universities".

The fund is the initiative of the province's Board of Industrial Leadership and Development (BILD), which coordinates the economic development program of the Ontario government.

According to a pamphlet describing the fund, any research discipline can qualify for support as long as the project is a new initiative and involves a pre-arranged partnership between a university and a corporation or consortium of corporations. If necessary, says the pamphlet, the ministry will put potential partners in touch with each other.

The maximum duration of any project supported by the fund will be three years. Basic and applied research projects are eligible, as are proposals aimed at improving production and manufacturing processes. Projects involving computer software development, however, will be given consideration only if they are a necessary part of broader proposals.

Universities wanting more information on the fund should write to the URIF secretariat, Ministry of Colleges and Universities, Queen's Park, Mowat Block, 9th floor, Toronto, Ont. M7A 1L2. Deadlines for grant applications are December 31, March 31 and July 31.

An assistance program of a different kind is being offered by IDEA Corporation, a provincial Crown agency established in 1981 to encourage and finance technological innovation.

The corporation has set aside $1 million a year for the next three years to help Ontario universities put their research into commercial and industrial use. In most cases the money will be used to support the activities of an individual, employed on staff or on a contract basis by the university, to search out new research developments that show commercial promise.

At those universities that already employ commercial development officers, IDEA's money will be used to increase their budgets for commercializing research.

The University of Guelph is one of several Ontario universities to participate in IDEA Corporation's new program to promote the commercialization of university research. Shown signing the agreement are Ian Macdonald (left), chairman of IDEA, and Burton Matthews, Guelph's president.

Two universities — Guelph and Queen's — have already signed up for the program. Other institutions — Carleton, Ottawa, McMaster, Waterloo and York — are expected to follow suit shortly, while negotiations are underway with the University of Toronto.

A slightly different arrangement is being made with Lakehead University, where the commercial development officer on campus will collaborate with a variety of organizations throughout northwestern Ontario to identify new technology needs of potential interest to university researchers.

Such partnerships between universities and business will be instrumental in developing Canada's technological competitiveness, states Ian Macdonald, chairman of IDEA and former president of York University.

Although the quality of Canadian research is generally high, says Mr Macdonald, not enough attention is being paid to the commercial development of this research.

"What Canadian industry and inventors need are mechanisms, on campus, that will uncover research projects with potential commercial merit.

"Clearly the needs of the industrialist must combine with the capabilities of the researcher", he says, adding that the commercial development officers program is one way of contributing to the process.

Once promising technologies are identified through the program they will be presented to IDEA for consideration. The corporation may then choose to invest in the early stages of pre-commercial development or assist in licensing. Proposals may also be directed to other potential investors and industrial sponsors.

This is the normal route that IDEA takes with any research proposal, be it from a university or an individual researcher. The corporation was set up with $91 million in block funding from BILD, which it uses to invest as "seed" capital in early-stage research projects.

In addition, IDEA acts as a technology licensing broker by helping to bring new products and processes to the marketplace. The corporation receives about 30 ideas a month from such sources as small businesses, engineers, private inventors and hospital, university and industrial laboratories.

Valerie Shore

YORK UNIVERSITY

Magna International Chair in Entrepreneurial Studies

FACULTY OF ADMINISTRATIVE STUDIES
4700 KEELE STREET, DOWNSVIEW, ONTARIO, CANADA M3J 2R6

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ENTREPRENEURIAL STUDIES PROGRAMME

SCOPE OF SUBJECT

The objective of this programme is to combine academic training with extensive exposure to individuals and firms from the small business and entrepreneurial sectors in Canada. The selection of recommended courses is designed to equip participants with the knowledge and skills needed to understand, manage, start-up and/or advise small business in Canada. The education provided also qualifies the participants for effective employment in those Government and larger private sector organizations that frequently interact with smaller firms. The Programme does not cater to small business interests exclusively. Entrepreneurial behaviour in larger organizations is an important focus in several courses.

CAREER POTENTIAL

Graduates from this programme have three types of employment options. They can work for small businesses, or enter their family business. Secondly, they can start or prepare for the start-up of a new entrepreneurial venture of their own. This option is particularly attractive to part-time students who are currently working and are looking for alternative career paths. And thirdly, almost all large private and public sector organizations need people in managerial positions who have the knowledge required to deal with small firms, e.g. credit officers of banks and development officers in governmental programmes. There is also an increased need in larger corporations for entrepreneurial managers who take responsibility for organizational renewal.

TEACHING PROGRAMME

Students with an interest in Entrepreneurial Studies should take Entrepreneurialship and Small Business (PLCY 6600) in the second term of their first year. This course is a prerequisite for subsequent courses in the programme. Students who have completed PLCY 6600, The Strategy Study (MGMT 6010) at an entrepreneurial site and at least two other courses in the Entrepreneurial Studies Programme are eligible to be nominated for an award, the Gold Medal for Excellence in Entrepreneurial Studies. Each year a committee selects one or more Strategy Study reports on entrepreneurial issues to receive the Outstanding Achievement Award plaque.

Students in the Programme will receive priority in hiring by the York Enterprise Development Centre. The York Enterprise Development Centre

(continued...)

operates a year round counselling programme for students wishing to gain work experience. Upon graduation, students wishing to work in smaller firms are offered placement assistance.

The principal courses in the Entrepreneurial Studies Programme are:

PLCY 6600 - Entrepreneurship and Small Business
PLCY 6620 - New Venture Formation
PLCY 6640 - Managing the Smaller Enterprise
PLCY 6660 - Advising Small Business
PLCY 6050 - Acquisitions, Mergers and Divestitures
MGMT 6010 - Strategy Study (Entrepreneurial Site)

Other recommended courses are:

ACTG 6400 - Managerial Cost Accounting & Analysis
ACTG 6450 - Management Accounting & Control Systems
ACTG 6710 - Introduction to Income Taxation
FINE 6100 - Financial Management
FINE 6150 - Advanced Corporate Finance
FINE 6200 - Investments
FINE 6250 - Applied Investments
MGTS 6500 - Issues & Cases in Production and Operations Management
MGTS 6510 - Scheduling & Planning of Operations
MGTS 6710 - Management Information Systems I
MKTG 6050 - Marketing Research
MKTG 6200 - Industrial (Organizational) Marketing
MKTG 6250 - Management of Marketing Channels
MKTG 6550 - Product Management
OBIR 6200 - Personnel Management
OBIR 6400 - Interpersonal Conflict, Politics & Power in Organizations
OBIR 6410 - Quality of Organizational Life
PLCY 6200 - Business Administration & the Law
PLCY 6410 - Introduction to International Business

RESEARCH PROGRAMME

The Director of the Entrepreneurial Studies Programme is Rein Peterson, who is the Magna International Professor of Entrepreneurial Studies at York University. Magna International Inc., one of the largest manufacturers of automotive parts in North America, founded this chair at York to encourage and support teaching and research on entrepreneurship in large, small and family owned businesses. The programme has also received funding from Shell Canada. One post doctoral research fellow from Sweden and three Canadian Ph.D. students are currently in residence. The following research projects are under way:

1. Entrepreneurship and Intrapreneurship: A Comparison of Climates for Innovation.

(continued...)

2. Cross-cultural Study of Entrepreneurial Characteristics (3,600 companies in 10 countries.)

3. Emerging Management Competences at the Senior Executive Level of Large and Medium sized Canadian Corporations.

4. Organizational Renewal and Growth in a Rapidly Growing Corporation.

5. Entrepreneurship and Economic Development.

6. Strategic Planning and Use of Accounting Information in Family Business.

For further information, contact Professor R. Peterson, Room 200F, Administrative Studies Building, telephone (416) 667-3034.

(continued...)

FACULTY IN ENTREPRENEURIAL STUDIES

Conrad, James R.

B.Eng.(Chem. McGill,) MBA(York)

Present Work Experience:
Executive Director, Canadian Federation of Independent Petroleum Marketers. Advocates the interests of the smaller independent oil companies to governments.

President and owner of Conrad Tax Preparation Service (16 employees.)

Research Interests:
Anti-Trust legislation and small business in Canada.

Coutts, G.

S.B.(M.I.T.,) MBA(York)

Present Work Experience:
President and Founder of Biomedical Engineering Shared Service Inc. Company provides service on sophisticated medical electronic equipment in hospitals, clinics, laboratories.

Research Interests:
Strategic management in small business.

Cunningham, G. G.

C.A.

Present Work Experience:
Partner in Management Consulting and Chartered Accounting Firms specializing in small and family business.

Research Interests:
Columnist and editor of several small business publications.

Peterson, R.

B.Eng.(McGill,) MBA(Western Ontario,) Ph.D. (Cornell,) Director, Entrepreneurial Studies.

Previous Work Experience:
Formerly Vice-President, Cape Breton Development Corporation, responsible for corporate planning, research, M.I.S. and marketing. Also involved in fostering small business start-ups and growth on Cape Breton.

(continued...)

Peterson, R. (cont'd...)

Research Interests:
Role of small and large firms in a balanced economy.
Fostering of technological entrepreneurship in large and small firms.
Fostering and developing entrepreneurship in economically underdeveloped areas.

Secretan, L.

B.A.(U.S.C.,) M.A.(U.S.C.,) Ph.D.(L.S.E.)

Previous Work Experience:
Managing Director and C.E.O., Manpower Limited (U.K.)

Present Work Experience:
Managing private investments and acting as a consultant.

Research Interests:
Entrepreneurship and New Venture Formation.

Tick, L.

B.Sc.(Toronto,) LL.B.(Osgoode,) LL.M.(London, England,) MBA(York.)

Present Work Experience:
Executive Vice-President A. E. Lepage Ltd.

Research Interests:
Commercial business law, mergers and acquisitions.

Zysman, S.

B.A.(Poli.Sci., Toronto,) C.A., D.B.A. (Harvard.)

Present Work Experience:
Secretary-Treasurer Convexco Limited (a family business.) A small multinational group manufacturing machinery and supplies for the upholstery and mattress industries.

Research Interests:
Strategic management in family business.

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  - The Industry/Innovation Centre Cooperative Program (School of Engineering)

  - Management of Technology Program

- York University

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ATTACHMENT "B"

RELATED MANITOBA RESOURCES

RESOURCES (EXISTING)

- UNIVERSITY COURSES IN ENTREPRENEURSHIP
  - FACULTY OF ADMINISTRATIVE STUDIES (University of Manitoba)
    e.g. 118:410 NEW VENTURE ANALYSIS/COVENY
    118:310 SMALL BUSINESS MANAGEMENT/LEVY
    29:309 MANAGEMENT OF R&D/BARTELL
    27:403 TECHNOLOGICAL ENTREPRENEURSHIP/OWEN
    ISSUES IN TECHNOLOGICAL CHANGE/BARTELL

- COMMUNITY COLLEGE PROGRAMS eg Red River Community College
  B12-P555 ENTREPRENEURSHIP VESPER/MUNT
  B13-M615) BUSINESS SEMINAR
  B13-M616) COURSES

- PRIVATE CONSULTANTS
  - HUMAN DEVELOPMENT CENTRE
  - OTHERS?

- BUSINESS DEVELOPMENT AND TOURISM PROGRAMS
  - FEASIBILITY ASSISTANCE FOR SMALL MANUFACTURERS (FASM)
    - CONSULTING ASSISTANCE TO PREPARE BUSINESS PLANS (50% TO $1,000)
  - VENTURE CAPITAL PROGRAM
    - SHARED INVESTMENT IN VENTURE CAPITAL COMPANIES.
  - MANAGEMENT DEVELOPMENT AND TRAINING PROGRAM (BUSINESS DEVELOPMENT CENTRE)
    - COURSES, SEMINARS FOR ENTREPRENEURS
    - BUSINESS MANAGEMENT SKILLS
  - GENERAL BUSINESS CONSULTING (BUSINESS DEVELOPMENT CENTRE)
    - INFORMATION (GUIDES, BOOKLETS, NEWSLETTER)
    - EXTENDED CONSULTING
  - SMALL BUSINESS ASSISTANCE PROGRAM (WINNIPEG CORE AREA INITIATIVE)
    - BUSINESS PLANNING
    - INCENTIVE GRANTS

RESOURCES (EXISTING) contd

- FEDERAL BUSINESS DEVELOPMENT BANK
  - FINANCING (LOANS, LOAN GUARANTEES, PLANNING, MATCHMAKING, BUSINESS KITS)
  - INVESTMENT BANKING
  - MANAGEMENT SERVICES (COUNSELLING (CASE PROGRAM) TRAINING, INFO, BUSINESS SEMINARS, CLINICS, COURSES INCLUDING STARTING YOU BURINSS, MARKETING, FINANCIAL, PERSONNEL).

- ENTREPRENEURS CLUB
  SELF HELP GROUP

- INDUSTRY, TRADE AND TECHNOLOGY
  - TECHNOLOGY COMMERCIALIZATION
    (INCUBATOR SPACE, BUSINESS ASSISTANCE, TECHNOLOGY TRANSFER, SEED CAPITAL).

  - MANITOBA RESEARCH COUNCIL'S INDUSTRIAL TECHNOLOGY CENTRE AND CANADIAN FOOD PRODUCTS DEVELOPMENT CENTRE
    (TECHNICAL INFORMATION AND SUPPORT)

- NATIONAL RESEARCH COUNCIL
  - TECHNICAL FIELD ADVISORY SERVICES
  - IRAP - TECHNICAL FEASIBILITY/APPLIED RESEARCH

- DEPARTMENT OF REGIONAL INDUSTRIAL EXPANSION (DRIE)
  - FINANCING (LOANS, GRANTS)
  - BUSINESS ADVICE

- CANADIAN PATENTS & DEVELOPMENT LTD. (CPDL)
  (COMMERCIAL EXPLOITATION OF INVENTIONS FROM UNIVERSITIES AND GOVERNMENT)

- WINNIPEG BUSINESS DEVELOPMENT CORPORATION
  (CITY OF WINNIPEG 90%, WCC 10%)
  . INFORMATION, REFERRALS, HANDHOLDING

- CANADIAN INDUSTRIAL INNOVATION CENTRES (WATERLOO/MONTREAL)
  - COMMERCIALIZATION ASSISTANCE TO INVENTORS
  - TEACHING OF ENTREPRENEURSHIP

- CPDL/DRIE
  INVENTORS ASSISTANCE PROGRAM
  - OFFERED THROUGH CIIC/WATERLOO AND CII/MONTREAL
  - ASSESSMENT OF TECHNICAL AND COMMERCIAL FEASIBILITY OF INVENTIONS

RESOURCES (PROPOSED)

- CHAIR OF ENTREPRENEURSHIP
  (FACULTY OF ADMINISTRATIVE STUDIES)
  (PRIVATE ENDOWMENT)

- PROJECT SOS - SELF OCCUPATIONAL STRATEGIES - AN ENTREPRENEURIAL JOB CREATION TRAINING PROGRAM
  (HUMAN DEVELOPMENT CENTRE/BUSINESS DEVELOPMENT AND TOURISM/EMPLOYMENT AND IMMIGRATION CANADA)

- ENTREPRENEURIAL PROJECT PROGRAM (RED RIVER COMMUNITY COLLEGE)

- STUDENTS INVOLVED IN CONTRIBUTING TO ACTUAL BUSINESS START-UPS (FIRST PROJECT-INTERACTIVE VIDEO-DISC PRE-MASTERING SYSTEM) JOINT VENTURE BETWEEN RED RIVER COMMUNITY COLLEGE/INDIVIDUAL COMPANIES.

ATTACHMENT "C"

POSSIBLE COURSES

POSSIBLE COURSES/CONTENT

- PRODUCT INNOVATION
- MARKET ANALYSIS/PREDICTION
- MARKETING
- DISTRIBUTION
- INNOVATION MANAGEMENT
- R&D MANAGEMENT
- TAX SHELTERING
- KEEPING UP WITH CHANGE
- APPROPRIATE SCALE TECHNOLOGY
- BUILDING A MANAGEMENT TEAM
- INTELLECTUAL PROPERTY LAW
- CORPORATION LAW
- LICENSING, FRANCHISING,
- ROYALTY AGREEMENTS, CASH FLOW FINANCING
- NATURE OF THE ENTREPRENEUR
- TECHNOLOGY TRANSFER
- GOVERNMENTAL PROGRAMS/ACCESSING SUPPORT
- PERSONAL EFFECTIVENESS
- RISK TAKING
- BUSINESS PLAN
- PROCESS INNOVATION
- OPPORTUNITY IDENTIFICATION
- NICHES IN THE MARKET
- R&D FUNDING
- RISK VENTURE FINANCING
- TECHNOLOGY MANAGEMENT
- PRODUCTIVITY THROUGH TECHNOLOGY
- PEOPLE MANAGEMENT
- SMALL BUSINESS MANAGEMENT
- CREATIVE THINKING
- INTRAPRENEURSHIP

ATTACHMENT "D"

POSSIBLE FUNDING SOURCES

POSSIBLE FUNDING SOURCES

. PROVINCE
- JOBS FUND
- MANITOBA, INDUSTRY TRADE AND TECHNOLOGY
- BUSINESS DEVELOPMENT AND TOURISM
- EDUCATION

. FEDERAL
- DEPARTMENT OF REGIONAL INDUSTRIAL EXPANSION/ECONOMIC REGIONAL DEVELOPMENT AGREEMENT
- CENTRES FOR ADVANCED TECHNOLOGY?
- CANADIAN INDUSTRIAL INNOVATION CENTRES
- NATIONAL SCIENCE AND ENGINEERING RESEARCH COUNCIL (NSERC)
- EMPLOYMENT & IMMIGRATION CANADA

(a) National Institutional Training Program
(b) Skills Growth Fund
(c) National Industrial Training Program

. UNIVERSITIES AND COLLEGES

. PRIVATE
- WINNIPEG CHAMBER OF COMMERCE/MANITOBA CHAMBER OF COMMERCE/CANADIAN MANUFACTURING ASSOCIATION AND OTHER BUSINESS ASSOCIATIONS
- PRIVATE OR CORPORATE ENDOWMENT

POOR
QUALITY
ORIGINAL